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Acoustic assessment and distribution of anchovy, sardine and chub mackerel in ICES Subdivision 9a South during the *ECOCADIZ-RECLUTAS 2020-10* Spanish survey (October 2020) with notes on the distribution of other pelagic species.

By

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ABSTRACT

The present working document summarises a part of the main results obtained during the *ECOCADIZ-RECLUTAS 2020-10* Spanish (pelagic ecosystem-) acoustic survey. The survey was conducted by IEO between 02nd and 21st October 2020 in the Portuguese and Spanish shelf waters (20-200 m isobaths) off the Gulf of Cadiz (GoC) onboard the R/V *Ramón Margalef*. The survey's main objective is the acoustic assessment of anchovy and sardine juveniles (age 0 fish) in the recruitment areas of the GoC. The 21 foreseen acoustic transects were sampled. A total of 22 valid fishing hauls were carried out for echo-trace ground-truthing purposes. This working document only provides abundance and biomass estimates for anchovy, sardine and chub mackerel, which are presented without age structure. The distribution of all the mid-sized and small pelagic fish species susceptible of being acoustically assessed is also shown from the mapping of their back-scattering energies. GoC anchovy acoustic estimates in autumn 2020, 36 070 t and 3197 million fish, showed a decrease in relation to the historical peak recorded the last year, but they were either close (abundance) or even higher (biomass) than the time-series average. As usual, the bulk of the population, including juveniles, was located in Spanish waters. GoC sardine experienced a huge increase in autumn 2020, rising up to its time-series maximum and yielding 208 400 t and 5451 million fish, with similar regional contributions to the population and with the juveniles being located in the Spanish coastal waters. Chub mackerel estimates were of 22 918 t and 295 million fish, representing a slight decrease compared with the last year, but still above the time-series average.

INTRODUCTION

The first attempt by the IEO of acoustically assessing the abundance of anchovy and sardine juveniles in their main recruitment areas off the Gulf of Cadiz dates back to 2009 (*ECOCADIZ-RECLUTAS 1009* survey). However, that survey was unsuccessful as to the achievement of their objectives because of the succession of a series of unforeseen problems which led to drastically reduce the foreseen sampling area to only the 6 easternmost transects. The continuation of this survey series was not guaranteed for next years and, in fact, no survey of these characteristics was carried out in 2010 and 2011. In 2012, the *ECOCADIZ-RECLUTAS 1112* survey was financed by the Spanish Fisheries Secretariat and planned and conducted by the IEO with the aim of obtaining an autumn estimate of Gulf of Cadiz anchovy biomass and abundance. The survey was conducted with the R/V *Emma Bardán*. Although the survey was restricted to the Spanish waters only it has been considered as the first survey within its series (Ramos *et al*., 2013). *ECOCADIZ-RECLUTAS 2014-10* re-started the series and it was conducted with the R/V *Ramón Margalef*. The 2017 survey should be the fifth survey within its series. However, an unexpected a serious breakdown of the vessel's propulsion system led to an early termination of the survey, which restricted the surveyed area to the one comprised by the seven easternmost transects only.

The general objective of these surveys is the acoustic assessment by vertical echo-integration and mapping of the abundance and biomass of recruits of small pelagic species (especially anchovy and sardine), as well as the mapping of both the oceanographic and biological conditions featuring the recruitment areas of these species in the Division 9a. The long term objective of the surveys would be to be able to assess the strength of the incoming recruitment to the fishery of these species the next year.

The present Working Document advances some results from the *ECOCADIZ-RECLUTAS 2020-10* survey (the sixth within its series), which will only refer to the acoustic estimates (not age-structured) and spatial distribution of anchovy, sardine and chub mackerel as well as to inferences on the spatial distribution of other pelagic species from the distribution of the acoustic energy attributed to each of them.

MATERIAL AND METHODS

The *ECOCADIZ-RECLUTAS 2020-10* survey was conducted between 2nd and 21st October 2020 onboard the Spanish R/V *Ramón Margalef* covering a survey area which comprised the waters of the Gulf of Cadiz, both Spanish and Portuguese, between the 20 m and 200 m isobaths. The survey design consisted in a systematic parallel grid with tracks equally spaced by 8 nm, normal to the shoreline (**Figure 1**).

Echo-integration was carried out with a recently installed *Simrad™ EK80* echo-sounder working in the multi-frequency fashion (18, 38, 70, 120, 200, 333 kHz) and in CW mode. Average survey speed was about 10 knots and the acoustic signals were integrated over 1-nm intervals (ESDU). Raw acoustic data were stored for further post-processing using *Myriax Software Echoview™* software package (by *Myriax Software Pty. Ltd.,* ex *SonarData Pty. Ltd.*). Acoustic equipment was calibrated between 3rd and 6th October in the Bay of Algeciras following the ICES standard procedures (Demer *et al*., 2015; see also Foote *et al*., 1987).

Survey execution and abundance estimation followed the methodologies firstly adopted by the ICES Planning Group for Acoustic Surveys in ICES Sub-Areas VIII and IX (ICES, 1998) and the recommendations given later by the *Working Group on Acoustic and Egg Surveys for Small Pelagic Fish in NE Atlantic* (WGACEGG; ICES, 2006a,b).

Fishing haulss for echo-trace ground-truthing were opportunistic, according to the echogram information, and they were carried out using a *Gloria HOD 352* pelagic trawl gear (ca. 10 m-mean vertical opening net) at an average speed of 4-4.5 knots. Gear performance and geometry during the effective fishing was monitored with *Simrad™ Mesotech FS20* trawl sonar, a *Marport™ Narrow Band Trawl Eye* and *Scanmar™* trawl door sensors for inter-doors distance and depth. Trawl sonar data from each haul were recorded and stored for further analyses.

Ground-truthing haul samples provided biological data on species and they were also used to identify fish species and to allocate the back-scattering values into fish species according to the proportions found at the fishing stations (Nakken and Dommasnes, 1975).

Length frequency distributions (LFD) by 0.5-cm class were obtained for all the fish species in trawl samples (either from the total catch or from a representative random sample of 100-200 fish). Only those LFDs based on a minimum of 30 individuals and showing a normal distribution were considered for the purpose of the acoustic assessment.

Given a shortage of personnel due to COVID-19 protocols the individual biological sampling (length, weight, sex, maturity stage, stomach fullness, and mesenteric fat content) was performed in each haul for anchovy, sardine and chub mackerel only. Otoliths were extracted from these three species.

The following TS/length relationship table was used for acoustic estimation of assessed species (recent IEO standards after ICES, 1998; and recommendations by ICES, 2006a,b):

Species	b_{20}
Sardine (*Sardina pilchardus*)	-72.6
Round sardinella (*Sardinella aurita*)	-72.6
Anchovy (*Engraulis encrasicolus*)	-72.6
Chub mackerel (*Scomber japonicus*)	-68.7
Mackerel (*S. scombrus*)	-84.9
Horse mackerel (*Trachurus trachurus*)	-68.7
Mediterranean horse-mackerel (*T. mediterraneus*)	-68.7
Blue jack mackerel (*T. picturatus*)	-68.7
Bogue (*Boops boops*)	-67.0
Transparent goby (*Aphia minuta*)	-67.5
Atlantic pomfret (*Brama brama*)	-67.5
Blue whiting (*Micromesistius poutassou*)	-67.5
Silvery lightfish/pearlside (*Maurolicus muelleri*)	-72.2
Longspine snipefish (*Macroramphosus scolopax*)	-80.0
Boarfish (*Capros aper*)	-66.2* (-72.6)

*Boarfish b_{20} estimate following to Fässler *et al*. (2013). Between parentheses the usual IEO value considered in previous surveys.

The *PESMA* software (J. Miquel, IEO, unpublished) has got implemented the needed procedures and routines for the acoustic assessment following the above approach and it has been the software package used for the acoustic estimation.

No continuous recording of SST, SSS and *in-vivo* fluorescence was possible to be carried out during the acoustic tracking because the thermosalinograph was under repair. Vertical profiles of hydrographical variables were also recorded by night from 178 $CTDO_2$ casts over 23 transects using a *Sea-bird Electronics™ SBE 911+ SEACAT* (with coupled *Datasonics* altimeter, *SBE 43* oximeter, *WetLabs ECO-FL-NTU* fluorimeter and *WetLabs C-Star 25 cm* transmissometer sensors) profiler (**Figure 2**). *VMADCP RDI 150 kHz* records were also continuously recorded by night between CTD stations. Census of top predators was not recorded during the survey.

RESULTS

Acoustic sampling

The acoustic sampling was restricted to the period comprised between 8th and 19th October. The complete grid (21 transects) was acoustically sampled (**Table 1**; **Figure 1**). The sampling scheme followed to accomplish this grid was conditioned by the conduction of Spanish Navy and Army exercises during the survey, which occupied all the Spanish shelf waters. The sampling experienced several "jumps" looking for space-time opportunity windows for the acoustic surveying trying to avoid such military exercises. Thus, the order and/or direction of the realization of the acoustic transects had to be modified on 10th, 12th, 13th, 14th and 18th October. The acoustic sampling was partially interrupted on 12th-13th October in order to satisfy the R/V's refueling and provisioning needs. The arrival of the tropical storm Barbara to the Gulf during the survey's last days (19th-20th October) caused a poor weather and rough sea, entailing losses of the acoustic signal which led to the repetition of the transect RA09 by changing the sailing direction over the transect. In order to perform the acoustic sampling with daylight, the acoustic sampling started at 06:40-06:45 UTC, although this time might vary depending on the duration of the works related with the hydrographic sampling the previous night.

Groundtruthing hauls

A total of twenty two (22) fishing operations for echo-trace ground-truthing (all of them were valid according to a correct gear performance and resulting catches), were carried out during the survey (**Table 2**, **Figure 3**). Because of many echo-traces usually occurred close to the bottom, all the pelagic hauls but PE04 (a pelagic haul *sensu stricto*) were carried out like a bottom-trawl haul, with the ground rope working over or very close to the bottom. Five hauls were performed over a determined isobath instead of being conducted over the acoustic transect. According to the above, the sampled depth range in the valid hauls oscillated between 33 and 188 m.

During the survey were captured 2 Chondrichthyan, 35 Osteichthyes, 3 Cephalopod, 2 Echinoderm, and several Cnidarian species. The percentage of occurrence of the more frequent fish species (sharks excluded) in the hauls is shown in the enclosed Text Table below (see also **Figure 4**). The pelagic ichthyofauna was both the most frequently captured species set and the one composing the bulk of the overall yields of the catches. Within this pelagic fish species set chub mackerel (86% presence index), anchovy (73%), mackerel (68%) and sardine (64%) were the most frequent species in the valid hauls, followed by bogue (36%), horse mackerel (32%), Mediterranean horse mackerel (23%) and blue jack mackerel (18%). Boarfish, longspine snipefish and pearlside showed an incidental occurrence in the hauls performed in the surveyed area. Round sardinella and blue whiting were absent in the catches.

For the purposes of the acoustic assessment, anchovy, sardine, mackerel species, horse & jack mackerel species, bogue, boarfish, snipefish and pearlside were initially considered as the survey target species. All the invertebrates, skates, rays and benthic fish species were excluded from the computation of the total catches in weight and in number from those fishing stations where they occurred. Catches of the remaining non-target fish species were included in an operational category termed as “Others”.

According to the above premises, during the survey were captured a total of 19 866 kg and 458 thousand fish (**Table 3**). Fifty three per cent (53%) of this “total” fished biomass corresponded to sardine, 17% to chub mackerel, 12% to anchovy, 11% to mackerel, 4% to horse mackerel, and contributions lower than 1% for the remaining species. The most abundant species in ground-truthing trawl hauls was sardine (46%), followed by anchovy (34%), chub mackerel and mackerel (9% and 8%, respectively), and horse mackerel (3%), with each of the remaining species accounting for equal to or less than 1%.

The species composition of these fishing hauls (as expressed in terms of percentages in number) is shown in **Figure 4**.

Species	OCCURRENCE (Number of valid hauls)	OCCURRENCE (% over Total valid hauls)	Total weight (Kg)	Total number
Scomber colias	19	86,36 %	3437,167	39632
Engraulis encrasicolus	16	72,73 %	2336,636	154483
Scomber scombrus	15	68,18 %	2148,937	38041
Sardina pilchardus	14	63,64 %	10605,051	209268
Merluccius merluccius	13	59,09 %	8,143	58
Boops boops	8	36,36 %	37,454	397
Trachurus trachurus	7	31,82 %	765,933	12967
Spondyliosoma cantharus	6	27,27 %	66,381	560
Mola mola	6	27,27 %	71,955	27
Trachurus mediterraneus	5	22,73 %	163,134	766
Diplodus vulgaris	5	22,73 %	94,929	648
Trachurus picturatus	4	18,18 %	56,546	706
Pagellus bellottii bellottii	4	18,18 %	2,565	25
Pagellus erythrinus	3	13,64 %	10,790	66
Diplodus bellottii	3	13,64 %	11,670	267
Spicara flexuosa	3	13,64 %	0,860	30
Macroramphosus scolopax	2	9,09 %	3,249	196
Pagellus acarne	2	9,09 %	2,417	12
Sarda sarda	2	9,09 %	3,110	2
Stromateus fiatola	2	9,09 %	1,720	4
Maurolicus muelleri	1	4,55 %	0,044	43
Zeus faber	1	4,55 %	1,520	1
Capros aper	1	4,55 %	0,030	5
Liza aurata	1	4,55 %	1,310	1
Remora brachyptera	1	4,55 %	0,010	1
Pomatomus saltatrix	1	4,55 %	0,295	1
Caranx rhonchus	1	4,55 %	16,830	34
Trachinotus ovatus	1	4,55 %	0,340	2
Pomadasys incisus	1	4,55 %	1,280	10
Diplodus annularis	1	4,55 %	0,075	2
Dentex gibbosus	1	4,55 %	2,770	1
Sparus aurata	1	4,55 %	0,430	1
Spicara maena	1	4,55 %	0,050	1
Xiphias gladius	1	4,55 %	8,715	1
Aphia minuta	1	4,55 %	0,001	3

Back-scattering energy attributed to the "pelagic assemblage" and individual species

A total of 310 nmi (ESDU) from 21 transects has been acoustically sampled by echo-integration for assessment purposes. The enclosed text table below provides the nautical area-scattering coefficients attributed to each of the selected target species and for the whole "pelagic fish assemblage".

S_A (m^2 nmi^{-2})	TOTAL	PIL	ANE	MAC	MAS	HOM	HMM	JAA	BOG	BOC	SNS	MAV
TOTAL AREA	229241	131553	45404	7453	32558	2395	1673	281	146	0	4	7774
%	100	57,4	19,8	3,3	14,2	1,0	0,7	0,1	0,1	0,0001	0,002	3,4
Portugal	99332	57999	2832	7428	22115	1419	0	240	50	0	4	7245
%	43,3	44,1	6,2	99,7	67,9	59,2	0	85,5	34,5	100	100	93,2
Spain	129909	73555	42572	25	10443	976	1673	41	95	0	0	529
%	56,7	55,9	93,8	0,3	32,1	40,8	100	14,5	65,5	0	0	6,8

For this "pelagic fish assemblage" has been estimated a total of 229 241 m^2 nmi^{-2}, the maximum value recorded throughout the time-series. The highest NASC value (13 108 m^2 nmi^{-2}) was recorded in the inner-shelf waters (40 m) in front of Quarteira (transect R16, **Figure 5**), although very close values were also recorded in the inner- and mid-shelf waters (32-69 m depth) of transects R08, R111, R13, R16 and R20. By species, sardine accounted for 57% of this total back-scattered energy, followed by anchovy (20%) and chub mackerel (14%), and the remaining species with relative contributions of acoustic energies lower than 4%.

According to the resulting values of integrated acoustic energy and the availability and representativeness of the length frequency distributions, the species acoustically assessed in the present survey finally were anchovy, sardine, mackerel, chub mackerel, blue jack mackerel, horse mackerel, Mediterranean horse mackerel, bogue, boarfish, snipefish and pearlside.

Spatial distribution and abundance/biomass estimates

Anchovy

Parameters of the survey's length-weight relationship for anchovy are given in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 6**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 7**. The estimated abundance and biomass by size class are given in **Table 5** and **Figure 8**. **Table 6** shows the time-series of estimates for the whole population and Age-0 fish. No age data are available for the 2020 survey.

Gulf of Cadiz anchovy (20% of the total NASC attributed to fish) was widely distributed in the surveyed area, although higher densities were recorded between east of Cape Santa Maria and Bay of Cadiz (**Figure 7**).

Overall anchovy acoustic estimates in autumn 2020 were of 3197 million fish and 36 070 tones (**Table 5**; **Figure 8**), entailing 42% and 25% decreases in abundance and biomass, respectively, in relation to the last year's estimates (5518 million, 48 398 t). Notwithstanding the above, the current overall estimates are either close (abundance) or above (biomass) the time-series average (i.e. 3270 million; 23 538 t), (see **Table 6** and **Figure 31**). By geographical strata, the Spanish waters yielded 95% (3051 million) and 91% (32 780 t) of the total estimated abundance and biomass in the Gulf, confirming the importance of these waters in

the species' distribution. The estimates for the Portuguese waters were 145 million and 3290 t (**Table 5; Figure 8**). No Age-0 estimates from the 2020 survey are yet available, but anchovies ≤10 cm size class (1028 million fish) accounted for 32% in numbers of the whole population, with almost all of them (99.9%) occurring in Spanish waters (**Table 5**; **Figure 8**; see also **Table 6**).

The size class range of the assessed anchovy population in autumn 2020 varied between the 7.5 and 17.5 cm size classes, with two modal classes, the main mode at 9.5 cm and a secondary mode at 13.5 cm. The size composition of anchovy throughout the surveyed area confirms the usual pattern exhibited by the species during the survey season, with the largest (and oldest) fish being distributed in the westernmost waters and the smallest (and youngest) ones concentrated in the surroundings of the Guadalquivir river mouth and adjacent shallow waters (**Figures 6** and **8**). The 2020 autumn estimates of mean size and weight are only referred to the whole population (11.9 cm, 11.3 g) and they were somewhat higher than their respective time-series averages (11.2 cm, 9.2 g).

Sardine

Parameters of the survey's size-weight relationship for sardine are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 9**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 10**. Estimated abundance and biomass by size are given in **Table 7** and **Figure 11**. **Table 8** shows the time-series of estimates for the whole population and Age-0 fish. No age data are available for the 2020 survey.

GoC sardine recorded a relatively high acoustic echo-integration in autumn 2020 (57% of the total NASC attributed to pelagic fish species assemblage), as a consequence of the occurrence of dense mid-water schools in the coastal fringe of the Spanish central waters of the Gulf (30-63 m depth) and Algarve waters (32-86 m), (**Figure 10**). Sardine was widely distributed all over the surveyed area (avoiding both western- and easternmost waters) and, as a consequence of the abovementioned occurrence of dense schools in coastal waters, with very high densities in the inner-middle shelf waters.

GoC sardine abundance and biomass in autumn 2020 were estimated at 5451 million fish and 208 400 t, the historical record within its series, as a result of huge increases in abundance and biomass in relation to the last year's estimates (937 million and 36 465 t; **Table 7**, **Figure 11**). Spanish waters concentrated 63% and 49% of the total estimated abundance and biomass, respectively (3445 million and 102 607 t), values that lead to infer the occurrence of the smallest sardines in these waters. The estimates for the Portuguese waters were 2006 million and 105 783 t. No Age-0 estimates from the 2020 survey are yet available. Juvenile sardines (≤11.5 cm) only occurred in Spanish waters; they amounted to 725 million fish, accounting for 13% of the whole population (**Table 7**, **Figure 11**; see also **Table 8**).

Sizes of the assessed sardine population in autumn 2020 ranged between 10.0 and 22.0 cm size classes. The length frequency distribution of the population was clearly bimodal, with one main mode at 18.0 cm size class and a secondary one at 11.0 cm (**Table 7**; **Figure 11**). No Age-0 estimates from the 2020 survey are yet available, but the juvenile fraction in the estimated population (≤11.5 cm), was mainly located in relatively shallow waters along the coastal fringe comprised between Matalascañas and the Bay of Cadiz (**Figures 9**, **10** and **11**). The 2020 autumn estimates of mean length and weight are so far only referred to the whole population (15.9 cm, 38.2 g), both are at the same level that the last year's estimates and are very close to the time-series averages (i,e. 15.6 cm, 37.3 g).

Mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 12**. The mapping of the

backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species is shown in **Figure 13**.

Atlantic mackerel (3% of the total NASC) showed a main density nucleus in the westernmost Algarve, showing an incidental occurrence in the central zone of the surveyed area (**Figure 13**).

The size range recorded in positive hauls was comprised between 18.5 and 34.5 cm size classes, with a dominant mode at 20.0 cm size class (mainly supported by fish from the Algarve waters) and a secondary mode at 27.5 cm (typical from the Spanish waters), (**Figure 12**).

Chub mackerel

Parameters of the survey's length-weight relationship are shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 14**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species and the coherent strata considered for the acoustic estimation are shown in **Figure 15**. Estimated abundance and biomass by size class are given in **Table 9** and **Figure 16**.

Chub mackerel (14% of the total NASC) was widely distributed in the surveyed area, but showing higher densities between Cape San Vicente and Mazagón (**Figure 15**). The species' positive hauls did not show a clear spatial pattern in (mean) size. However, the smallest fish were recorded in the inner-middle shelf waters between Matalascañas and the Bay of Cadiz (**Table 9**; **Figures 14** and **16**).

Chub mackerel abundance and biomass in the surveyed area were of 295 million fish and 22 918 t (**Table 9**, **Figure 16**). Portuguese waters accounted for 73% (216 million) and 72% (16 538 t) of the total abundance and biomass, respectively. Spanish waters yielded a population of 79 million and 6381 t.

The size range recorded for the estimated population was comprised between 17.5 and 36.5 cm size classes, with two equally represented modes at 20.0 and 22.0 cm size classes. A rather similar size composition is also recorded for the estimated biomass, although the mode at 22.0 cm dominates over the smaller mode (**Table 9**, **Figure 16**). Regional size compositions showed very similar shapes.

Horse mackerel

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 17**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species is shown in **Figure 18**.

Horse mackerel (1% of the total NASC) showed a very scattered distribution, with main density nuclei in both extremes of the surveyed area and around Cape Santa Maria (**Figure 18**).

The size range recorded in positive hauls was comprised between 7.5 and 28.5 cm size classes, with a dominant mode at 18.5 cm size class and a secondary mode at 23.0 cm. Smaller fish were recorded in the Spanish waters (**Figure 17**).

Mediterranean horse-mackerel

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 19**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species is shown in **Figure 20**.

Mediterranean horse mackerel (1% of the total NASC) was a typically Spanish species in autumn 2020. The species distributed over the Spanish eastern and central waters, not further west than the Tinto-Odiel river mouth, mainly over the inner-mid shelf waters (**Figure 20**). The species showed a wide range of sizes in the positive hauls (5.5-46.5 cm size classes; modes at 29.0, 27.0 and 23.0 size classes in decreasing order of importance), with larger fish occurring in deeper hauls of the easternmost waters of the surveyed area (**Figure 19**).

Blue jack mackerel

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 21**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species is shown in **Figure 22**.

Blue jack mackerel (0.1% of the total NASC) showed very weak acoustic densities. It was restricted almost exclusively to eastern Algarve shelf waters and incidentally in the easternmost Spanish waters (**Figure 22**). The overall size class in positive hauls ranged between 18.5 and 33.5 cm (mode at 20.0 cm size class). Smaller fish were mainly recorded in the Algarve waters (**Figure 21**).

Bogue

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 23**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species is shown in **Figure 24**.

Bogue (0.1% of the total NASC) showed a scattered distribution, showing relatively low acoustic densities (**Figure 24**). Although smaller fish seems to occur in the easternmost waters, no clear spatial pattern in size was clearly detected in the surveyed area (**Figure 23**). The overall size range in positive hauls was comprised between 16.0 and 31.5 size classes (mode at 21.5 cm size class).

Boarfish

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 25**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species is shown in **Figure 26**.

The occurrence of boarfish (0.0001%) was incidental and restricted to the outer shelf waters around Cape Santa Maria, co-occurring with longspine snipefish (**Figure 26**). The size range recorded in the only positive haul was comprised between 6.0 and 7.0 cm size classes, without any differentiated mode (**Figure 25**).

Longspine snipefish

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 27**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species is shown in **Figure 28**.

Longspine snipefish (0.002%) showed relatively low acoustic densities, which were restricted to the eastern Algarve waters (**Figure 28**). The species showed a concurrent distribution with boarfish. The size

range recorded in the positive hauls was comprised between 11.0 and 17.0 cm size classes, with a mode at 14 cm size class (**Figure 27**).

Pearlside

The survey's length-weight relationship for this species is shown in **Table 4**. Size composition and mean size in the fishing hauls are represented in the spatial context in **Figure 29**. The mapping of the backscattering energy (nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species is shown in **Figure 30**.

Pearlside (3%) was relatively common over the shelf break, especially in the western Algarve waters (**Figure 30**). The size range in the positive haul varied between 3.0 and 6.0 cm size class (mode at 4.5 cm size class; **Figure 29**).

(SHORT) DISCUSSION

The time series of anchovy and sardine estimates from this survey series are described in **Tables 6** and **8** and **Figure 31**.

GoC anchovy population in autumn 2020 (3197 million fish, 36 070 t) experienced 42% and 25% decreases in abundance and biomass, respectively, in relation to the last year's autumn estimates (5518 million, 48 398 t; **Table 6**; **Figure 31**). Notwithstanding the above, the current overall estimates are still either close (abundance) or above (biomass) the time-series average (i.e. 3270 million; 23 538 t). Although the age structure of the 2020 estimates are not yet available, the proxy of considering anchovies ≤10 cm size class as juveniles yielded values of 1028 million fish, which accounted for 32% in numbers of the whole population, with almost all of them (99.9%) occurring in Spanish waters.

GoC sardine abundance (5451 million fish) and biomass (208 400 t) in autumn 2020 peaked at their historical maxima within its series, representing huge increases in abundance and biomass in relation to the last year's autumn estimates (937 million and 36 465 t; **Table 8**; **Figure 31**). Causes for such an increase should be investigated in detail. Interestingly, PELAGO 20 estimated in spring this year 6547 million fish and 155 017 t, whereas ECOCADIZ 2020-07 estimated this summer only 1923 million fish (three times less than in PELAGO) and 50 721 t (five times less), suggesting changes in the availability of the species to the surveys or even possible movements between other northernmost sub-areas. Thus, IBERAS 0920, conducted one month before than ECOCADIZ-RECLUTAS, detected and estimated relatively high densities of sardine in the southernmost waters from the 9a Central-South subarea, a distribution pattern which could be also extended to the westernmost Algarve waters indicating some connectivity. Sardines ≤11.5 cm, as a proxy of juveniles/recruits, only accounted 13% of the whole population in the Gulf.

Chub mackerel abundance (295 million fish) and biomass (22 918 t) in autumn 2020 experienced 20% and 13% decreases respectively in relation to the estimates recorded the last year, although they still are above their respective time-series averages (i.e. 197 million, 14 001 t).

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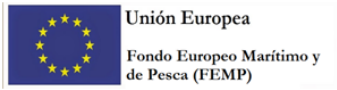

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Table 1. *ECOCADIZ-RECLUTAS 2020-10* survey. Descriptive characteristics of the acoustic tracks.

Acoustic Track	Location	Date	Start				End			
			Latitude	Longitude	UTC time	Mean depth (m)	Latitude	Longitude	UTC time	Mean depth (m)
R01	**Trafalgar**	08/10/20	36º 12,890' N	6º 09,00' W	13:15	24	38º 02,0680' N	6º 28,9474' W	15:16	239
R02	**Sancti-Petri**	09/10/20	36º 19,330' N	6º 14,950' W	06:44	26	36º 08,907' N	6º 14,860' W	14:48	28
R03	**Cádiz**	13/10/20	36º 26,709' N	6º 19,021' W	13:52	24	36º 17,264' N	6º 36,390' W	15:37	187
R04	**Rota**	10/10/20	36º 34,735' N	6º 22,146' W	04:49	19	36º 27,739' N	6º 34,930' W	11:09	86
R05	**Chipiona**	10/10/20	36º 31,217' N	6º 46,299' W	13:45	196	36º 40,389' N	6º 29,462' W	17:36	21
R06	**Doñana**	11/10/20	36º 46,578' N	6º 35,806' W	06:41	21	36º 38,047' N	6º 51,507' W	09:52	195
R07	**Matalascañas**	11/10/20	36º 44,009' N	6º 58,357' W	10:47	200	36º 53,949' N	6º 39,976' W	14:30	19
R08	**Mazagón**	19/10/20	36º 49,401' N	7º 06,042' W	13:59	197	37º 01,111' N	6º 44,645' W	14:08	22
R09	**Punta Umbría**	19/10/20	36º 49,732' N	7º 06,459' W	08:29	192	37º 04,294' N	6º 56,138' W	10:16	22
R10	**El Rompido**	18/10/20	36º 50,087' N	7º 07,207' W	11:34	196	37º 07,993' N	7º 07,225' W	17:26	19
R11	**Isla Cristina**	18/10/20	37º 06,884' N	7º 17,218' W	06:48	21	36º 53,544' N	7º 17,105' W	09:58	188
R12	**V.R. do Sto. Antonio**	12/10/20	37º 06,457' N	7º 27,201' W	06:42	20	37º 56,277' N	7º 27,100' W	09:19	203
R13	**Tavira**	12/10/20	36º 57,094' N	7º 37,117' W	10:41	190	37º 05,207' N	7º 37,223' W	13:36	16
R14	**Fuzeta**	14/10/20	36º 59,133' N	7º 47,102' W	06:40	47	36º 55,4622' N	7º 47,020' W	7:03	197
R15	**Cabo Sta. María**	14/10/20	36º 55,879' N	7º 57,001' W	12:55	59	36º 52,142' N	7º 56,931' W	13:18	198
R16	**Quarteira**	15/10/20	37º 01,787' N	8º 06,961' W	06:45	18	36º 49,647' N	8º 06,811' W	11:10	231
R17	**Albufeira**	15/10/20	36º 49,451' N	8º 16,810' W	13:52	195	37º 01,820' N	8º 17,037' W	17:25	23
R18	**Alfanzinha**	16/10/20	37º 04,601' N	8º 27,000' W	06:41	19	36º 50,260' N	8º 26,742' W	09:29	200
R19	**Portimao**	16/10/20	36º 51,914' N	8º 36,743' W	10:52	150	37º 04,297' N	8º 37,0639' W	12:08	38
R20	**Burgau**	17/10/20	37º 02,564' N	8º 46,947' W	06:47	43	36º 51,954' N	8º 46,661' W	09:52	201
R21	**Punta de Sagres**	17/10/20	36º 59,601' N	8º 56,610' W	10:50	202	36º 59,166' N	8º 56,826' W	13:52	28

Table 2. *ECOCADIZ-RECLUTAS 2020-10* survey. Descriptive characteristics of the fishing hauls.

Fishing haul	Date	Start		End		UTC Time		Depth (m)		Duration (min)		Trawled Distance (nm)	Acoustic Transect	Zone (landmark)
		Latitude	Longitude	Latitude	Longitude	Start	End	Start	End	Effective Trawling	Total Manoeuvre			
1	09-10-2020	36º 15.6561 N	6º 21.6670 W	36º 16.8371 N	6º 19.5417 W	08:05	08:33	48,03	43,22	00:28	00:57	2,084	R02	Sancti-Petri
2	09-10-2020	36º 10.4557 N	6º 31.2778 W	36º 11.5843 N	6º 29.1892 W	11:44	12:12	116,31	104,48	00:28	01:13	2,032	R02	Sancti-Petri
3	10-10-2020	36º 30.6958 N	6º 29.6509 W	36º 32.0930 N	6º 27.1630 W	07:59	08:34	52,38	42,54	00:34	01:09	2,443	R04	Rota
4	10-10-2020	36º 28.7326 N	6º 32.8414 W	36º 27.2053 N	6º 35.8465 W	11:43	12:23	71,03	92,94	00:39	01:21	2,864	R04	Rota
5	10-10-2020	36º 34.1240 N	6º 40.6945 W	36º 32.5679 N	6º 43.5229 W	14:43	15:21	87,63	114,32	00:37	01:26	2,758	R05	Chipiona
6	11-10-2020	36º 42.3433 N	6º 43.4835 W	36º 43.7336 N	6º 41.2683 W	07:52	08:24	63,41	42,76	00:31	01:07	2,258	R06	Doñana
7	11-10-2020	36º 46.0157 N	6º 54.6393 W	36º 44.7045 N	6º 56.9161 W	11:40	12:10	107,62	128,05	00:30	01:16	2,250	R07	Matalascañas
8	11-10-2020	36º 52.1608 N	6º 43.6533 W	36º 50.7808 N	6º 46.1011 W	15:54	16:27	25,64	40,06	00:33	01:46	2,400	R07	Matalascañas
9	12-10-2020	37º 02.5066 N	7º 27.1986 W	37º 03.9725 N	7º 27.1390 W	07:39	07:59	79,3	54,21	00:20	01:01	1,465	R12	Vila R. do Sto Antonio
10	12-10-2020	37º 00.3793 N	7º 37.1516 W	36º 57.6279 N	7º 37.9578 W	11:28	12:09	94,21	156,81	00:41	01:30	2,823	R13	Tavira
11	14-10-2020	36º 56.8597 N	7º 47.6118 W	36º 57.4938 N	7º 45.6502 W	08:03	08:26	84,3	88,53	00:23	01:12	1,695	R14	Fuzeta
12	14-10-2020	36º 59.2888 N	7º 44.9026 W	36º 58.2829 N	7º 47.7953 W	11:08	11:42	72,11	68,23	00:34	01:20	2,526	R14	Fuzeta
13	15-10-2020	36º 58.0247 N	8º 08.4612 W	36º 56.7755 N	8º 06.0614 W	08:37	09:08	42,77	44,09	00:31	01:08	2,293	R16	Quarteira
14	15-10-2020	36º 52.3596 N	8º 06.7448 W	36º 54.7944 N	8º 06.9393 W	11:43	12:16	100,89	64,09	00:33	01:15	2,437	R16	Quarteira
15	15-10-2020	36º 50.1007 N	8º 16.9764 W	36º 49.7740 N	8º 19.0655 W	14:54	15:17	122,97	166,09	00:23	01:17	1,709	R17	Albufeira
16	16-10-2020	36º 54.1264 N	8º 26.7725 W	36º 56.6928 N	8º 26.7991 W	08:07	08:42	115,3	91,23	00:34	01:18	2,563	R18	Alfanzina
17	16-10-2020	37º 02.9482 N	8º 38.2395 W	37º 03.4007 N	8º 36.4118 W	14:04	14:24	41,9	41,57	00:20	00:58	1,531	R19	Portimao
18	17-10-2020	36º 54.0899 N	8º 46.5827 W	36º 56.6435 N	8º 46.7312 W	08:08	08:44	105,88	107,43	00:35	01:24	2,553	R20	Burgau
19	17-10-2020	36º 55.1512 N	8º 56.6046 W	36º 52.2794 N	8º 56.7159 W	11:49	12:29	109,74	131,71	00:40	01:29	2,869	R21	Ponta de Sagres
20	18-10-2020	37º 01.4012 N	7º 17.2076 W	37º 03.4647 N	7º 17.1726 W	07:50	08:20	49,24	35,13	00:30	01:12	2,061	R11	Isla Cristina
21	18-10-2020	36º 55.9432 N	7º 07.1252 W	36º 53.1814 N	7º 07.0994 W	12:36	13:29	96,22	115,65	00:53	01:27	2,758	R10	El Rompido
22	18-10-2020	37º 00.0879 N	7º 07.1781 W	36º 58.1016 N	7º 07.1189 W	15:25	15:52	61,7	80,91	00:27	01:07	1,984	R10	El Rompido

Table 3. *ECOCADIZ-RECLUTAS 2020-10* survey. Catches by species in number (upper panel) and weight (in kg, lower panel) from valid fishing stations.

Fishing haul	CATCH IN NUMBER												
	Anchovy	*Sardine*	*Chub mack.*	*Mackerel*	*Blue Jack mack.*	*Horse-mack.*	*Medit. Horse-mack.*	*Bogue*	*Boarfish*	*Snipefish*	*Pearlside*	Other spp.	TOTAL
01	0	166	967	0	0	9375	688	375	0	0	0	1153	**12724**
02	0	0	3	0	79	0	41	1	0	0	0	3	**127**
03	4397	1100	0	0	0	0	33	0	0	0	0	42	**5572**
04	7138	6467	4	0	0	0	0	0	0	0	0	4	**13613**
05	61240	5019	133	24	0	0	0	0	0	0	0	9	**66425**
06	1297	1196	0	4	0	0	0	0	0	0	0	3	**2500**
07	7340	0	14697	62	0	0	0	0	0	0	0	0	**22099**
08	10576	9084	1	3	0	0	3	0	0	0	0	331	**19998**
09	403	2211	9550	2	0	0	0	0	0	0	0	0	**12166**
10	5184	5194	2359	23	66	0	0	2	0	168	0	7	**13003**
11	2935	1658	1050	414	560	3525	0	3	5	28	0	4	**10182**
12	166	52260	0	0	0	0	0	0	0	0	0	2	**52428**
13	3	57632	2315	0	0	0	0	0	0	0	0	98	**60048**
14	434	0	2411	4116	0	0	0	0	0	0	0	10	**6971**
15	0	0	5	184	1	0	0	0	0	0	43	12	**245**
16	16452	0	96	5695	0	44	0	3	0	0	0	10	**22300**
17	260	6181	5	0	0	4	0	3	0	0	0	39	**6492**
18	0	0	199	18076	0	2	0	0	0	0	0	3	**18280**
19	0	0	479	9296	0	5	0	4	0	0	0	3	**9787**
20	0	61097	2576	6	0	12	1	6	0	0	0	17	**63715**
21	35149	0	2760	124	0	0	0	0	0	0	0	2	**38035**
22	1509	3	22	12	0	0	0	0	0	0	0	4	**1550**
TOTAL	**154483**	**209268**	**39632**	**38041**	**706**	**12967**	**766**	**397**	**5**	**196**	**43**	**1756**	**458260**

Table 3. *ECOCADIZ-RECLUTAS 2020-10* survey. Cont'd.

Fishing haul	CATCH IN WEIGHT (kg)												
	Anchovy	***Sardine***	***Chub mack.***	***Mackerel***	***Blue Jack mack.***	***Horse-mack.***	***Medit. Horse-mack.***	***Bogue***	***Boarfish***	***Snipefish***	***Pearlside***	**Other spp.**	**TOTAL**
01	0	9,685	100,467	0	0	467,612	135,209	34,399	0	0	0	155,857	**903,229**
02	0	0	0,685	0	11,215	0	18,820	0,095	0	0	0	0,295	**31,110**
03	28,055	17,840	0	0	0	0	8,285	0	0	0	0	17,960	**72,140**
04	48,979	126,418	0,208	0	0	0	0	0	0	0	0	0,740	**176,345**
05	779,129	104,033	6,485	3,725	0	0	0	0	0	0	0	6,401	**899,773**
06	6,360	22,590	0	0,690	0	0	0	0	0	0	0	0,655	**30,295**
07	120,232	0	1503,686	9,741	0	0	0	0	0	0	0	0	**1633,659**
08	55,701	141,060	0,120	0,490	0	0	0,560	0	0	0	0	21,335	**219,266**
09	6,447	103,388	661,298	0,552	0	0	0	0	0	0	0	0	**771,685**
10	96,591	281,462	180,902	1,380	5,580	0	0	0,285	0	2,875	0	3,590	**572,665**
11	53,423	83,807	87,201	23,468	39,649	291,841	0	0,450	0,030	0,374	0	2,495	**582,738**
12	2,759	2833,056	0	0	0	0	0	0	0	0	0	0,495	**2836,310**
13	0,052	3151,443	209,078	0	0	0	0	0	0	0	0	15,313	**3375,886**
14	11,415	0	163,252	214,402	0	0	0	0	0	0	0	1,370	**390,439**
15	0	0	0,378	10,820	0,102	0	0	0	0	0	0,044	20,530	**31,874**
16	448,198	0	8,110	334,519	0	4,735	0	0,395	0	0	0	9,685	**805,642**
17	5,370	346,770	0,390	0	0	0,335	0	0,220	0	0	0	38,100	**391,185**
18	0	0	17,790	999,115	0	0,245	0	0	0	0	0	0,595	**1017,745**
19	0	0	58,755	523,745	0	0,715	0	0,415	0	0	0	0,820	**584,4500**
20	0	3383,409	183,172	1,480	0	0,450	0,260	1,195	0	0	0	2,310	**3572,276**
21	659,000	0	253,690	22,220	0	0	0	0	0	0	0	2,825	**937,735**
22	14,925	0,090	1,500	2,590	0	0	0	0	0	0	0	10,440	**29,545**
TOTAL	**2336,636**	**10605,051**	**3437,167**	**2148,937**	**56,546**	**765,933**	**163,134**	**37,454**	**0,030**	**3,249**	**0,044**	**311,811**	**19865,992**

Table 4. *ECOCADIZ-RECLUTAS 2020-10* survey. Parameters of the size-weight relationships for the survey's target species susceptible of being assessed. FAO codes for the species: ANE: *Engraulis encrasicolus*; PIL: *Sardina pilchardus*; VAM: *Scomber colias*; MAC: S. *scombrus*; JAA: *Trachurus picturatus*; HOM: *T. trachurus*; HMM: *T. mediterraneus*; BOG: *Boops boops*; POA: *Brama brama*; BOC: *Capros aper*; SNS: *Macroramphosus scolopax*; MAV: *Maurolicus muelleri*.

Parameter	ANE	PIL	VAM	MAC	JAA	HOM	HMM	BOG	BOC	SNS	MAV
Size range (mm)	81-182	110-222	177-396	191-346	185-339	77-285	57-466	164-310	63-74	111-170	32-63
n	782	683	690	462	165	157	125	22	5	169	43
a	0.001748530	0.001951537	0.002745174	0.002565026	0.004480958	0.053022878	0.012904912	0.926958852	0.050078582	0.011618897	0.010776177
b	3.502940	3.526670	3.325389	3.305719	3.169282	2.381583	2.831593	1.563943	2.510806	2.722675	2.830778
r^2	0.9862151	0.9744992	0.9496379	0.9842858	0.9803037	0.7692541	0.9949514	0.4102040	0.9887192	0.8505975	0.9080930

Table 5. *ECOCADIZ-RECLUTAS 2020-10* survey. Anchovy (*E. encrasicolus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 7**.

***ECOCADIZ-RECLUTAS 2020-10* . *Engraulis encrasicolus* . ABUNDANCE (in numbers and million fish)**														
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	***n***			**Millions**		
									PORTUGAL	**SPAIN**	**TOTAL**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7,5	0	0	0	0	0	4374875	0	0	0	4374875	4374875	0	4	4
8	0	0	0	0	0	30534570	0	2176528	0	32711098	32711098	0	33	33
8,5	0	0	0	0	0	87518833	0	6529583	0	94048416	94048416	0	94	94
9	0	0	0	0	711651	161435446	0	60781051	0	222928148	222928148	0	223	223
9,5	0	0	0	0	2134952	180011614	4203504	177595414	0	363945484	363945484	0	364	364
10	0	0	370198	2882530	4269904	101012283	0	201415294	370198	309580011	309950209	0	310	310
10,5	0	0	325621	2535431	9963109	37318628	4203504	179911204	325621	233931876	234257497	0	234	234
11	0	0	223097	1737133	37598875	8965084	4203504	107649723	223097	160154319	160377416	0	160	160
11,5	0	0	722978	5629435	41868779	13401802	33569647	77281979	722978	171751642	172474620	1	172	172
12	0	0	1226699	9551631	49696935	4436718	151063412	56670902	1226699	271419598	272646297	1	271	273
12,5	0	0	4128632	32147400	19214567	1458292	214013798	17748826	4128632	284582883	288711515	4	285	289
13	591522	620167	7699363	59950726	9251458	0	209810294	11811269	8911052	290823747	299734799	9	291	300
13,5	2535093	2112224	14364746	111850411	2846603	0	180444151	5937557	19012063	301078722	320090785	19	301	320
14	8619315	5380241	10124829	78836500	1423301	0	75531706	1979186	24124385	157770693	181895078	24	158	182
14,5	5999719	9601248	7992472	62233000	0	0	16784824	1979186	23593439	80997010	104590449	24	81	105
15	3126614	12588942	4423228	34441256	0	0	0	0	20138784	34441256	54580040	20	34	55
15,5	1014037	16175600	2645595	20599801	0	0	0	0	19835232	20599801	40435033	20	21	40
16	0	10583350	1119236	8714878	0	0	0	0	11702586	8714878	20417464	12	9	20
16,5	84503	7623372	527796	4109662	0	0	0	1979186	8235671	6088848	14324519	8	6	14
17	0	2129338	133236	1037437	0	0	0	0	2262574	1037437	3300011	2	1	3
17,5	0	473682	44136	343660	0	0	0	0	517818	343660	861478	1	0,3	1
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19,5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	21970803	67288164	56071862	436600891	178980134	630468145	893828344	911446888	145330829	3051324402	3196655231	**145**	**3051**	**3197**
Millions	**22**	**67**	**56**	**437**	**179**	**630**	**894**	**911**						

Table 5. *ECOCADIZ-RECLUTAS 2020-10* survey. Anchovy (*E. encrasicolus*). Cont'd.

ECOCADIZ-RECLUTAS 2020-10 . *Engraulis encrasicolus* . BIOMASS (t)											
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**POL08**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	**0**	**0**	**0**
6,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7	0	0	0	0	0	0	0	0	**0**	**0**	**0**
7,5	0	0	0	0	0	9,973	0	0	**0**	**9,973**	**9,973**
8	0	0	0	0	0	86,646	0	6,176	**0**	**92,822**	**92,822**
8,5	0	0	0	0	0	305,191	0	22,77	**0**	**327,961**	**327,961**
9	0	0	0	0	3,015	683,925	0	257,5	**0**	**944,440**	**944,440**
9,5	0	0	0	0	10,876	917,059	21,415	904,75	**0**	**1854,100**	**1854,100**
10	0	0	2,247	17,497	25,918	613,129	0	1222,561	**2,247**	**1879,105**	**1881,352**
10,5	0	0	2,335	18,184	71,455	267,646	30,147	1290,307	**2,335**	**1677,739**	**1680,074**
11	0	0	1,876	14,609	316,207	75,397	35,352	905,337	**1,876**	**1346,902**	**1348,778**
11,5	0	0	7,081	55,134	410,055	131,255	328,775	756,885	**7,081**	**1682,104**	**1689,185**
12	0	0	13,902	108,25	563,220	50,282	1712,015	642,256	**13,902**	**3076,023**	**3089,925**
12,5	0	0	53,829	419,136	250,518	19,013	2790,298	231,408	**53,829**	**3710,373**	**3764,202**
13	8,825	9,252	114,864	894,38	138,019	0	3130,074	176,207	**132,941**	**4338,680**	**4471,621**
13,5	43,060	35,877	243,993	1899,838	48,351	0	3064,939	100,853	**322,930**	**5113,981**	**5436,911**
14	165,917	103,566	194,897	1517,555	27,398	0	1453,940	38,098	**464,380**	**3036,991**	**3501,371**
14,5	130,320	208,549	173,605	1351,767	0	0	364,584	42,99	**512,474**	**1759,341**	**2271,815**
15	76,326	307,316	107,978	840,766	0	0	0	0	**491,620**	**840,766**	**1332,386**
15,5	27,716	442,115	72,310	563,038	0	0	0	0	**542,141**	**563,038**	**1105,179**
16	0	322,733	34,130	265,755	0	0	0	0	**356,863**	**265,755**	**622,618**
16,5	2,865	258,506	17,897	139,357	0	0	0	67,114	**279,268**	**206,471**	**485,739**
17	0	80,042	5,008	38,997	0	0	0	0	**85,050**	**38,997**	**124,047**
17,5	0	19,68	1,834	14,278	0	0	0	0	**21,514**	**14,278**	**35,792**
18	0	0	0	0	0	0	0	0	**0**	**0**	**0**
18,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
19	0	0	0	0	0	0	0	0	**0**	**0**	**0**
19,5	0	0	0	0	0	0	0	0	**0**	**0**	**0**
20	0	0	0	0	0	0	0	0	**0**	**0**	**0**
TOTAL	**455,029**	**1787,636**	**1047,786**	**8158,541**	**1865,032**	**3159,516**	**12931,539**	**6665,212**	**3290,451**	**32779,840**	**36070,291**

Table 6. *ECOCADIZ-RECLUTAS* surveys series. Anchovy (*E. encrasicolus*). Acoustic estimates of biomass (t) and abundance (million fish) for the whole Gulf of Cadiz anchovy population and for the juvenile fraction (*i.e*. age 0 fish, between parentheses). Age-0 estimates for 2020 not yet available. Note that the 2012 survey only surveyed the Spanish waters. The 2017 estimates correspond to an incomplete coverage (only the seven easternmost transects) of the standard surveyed area due to a research vessels' breakdown.

Estimate/Year	Total Population (Recruits at age 0)							
	2012	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Biomass (t)	13680 (13354)	8113 (5131)	30827 (29219)	19861 (15969)	7642 (7290)	10493 (3834)	48357 (36405)	36070 (n.a.)
Abundance (millions)	2469 (2619)	986 (814)	5227 (5117)	3667 (3445)	1492 (1433)	953 (543)	5505 (4845)	3197 (n.a.)

Table 7. *ECOCADIZ-RECLUTAS 2020-10* survey. Sardine (*Sardina pilchardus*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (i.e., coherent or homogeneous post-strata) numbered as in **Figure 11**.

ECOCADIZ-RECLUTAS 2020-10. Sardina pilchardus . ABUNDANCE (in numbers and million fish)												
Size class	POL01	POL02	POL03	POL04	POL05	POL06	*n*			Millions		
							PORTUGAL	SPAIN	TOTAL	PORTUGAL	SPAIN	TOTAL
6	0	0	0	0	0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0
7,5	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0
8,5	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0
9,5	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	33871508	0	0	0	0	33871508	33871508	0	34	34
10,5	0	0	140398695	0	0	0	0	140398695	140398695	0	140	140
11	0	0	290493433	2511166	0	0	0	293004599	293004599	0	293	293
11,5	0	0	237229840	9534189	10606052	0	0	257370081	257370081	0	257	257
12	0	0	155007399	29139447	88111819	0	0	272258665	272258665	0	272	272
12,5	0	0	40464817	40468827	182342515	0	0	263276159	263276159	0	263	263
13	0	0	38137767	107216466	111771475	0	0	257125708	257125708	0	257	257
13,5	0	0	57142010	147478635	25699281	0	0	230319926	230319926	0	230	230
14	2381260	1493391	42404026	125878851	13053603	0	2381260	182829871	185211131	2	183	185
14,5	10017664	6282509	38654889	50183022	8566427	0	10017664	103686847	113704511	10	104	114
15	20216017	12678336	37879206	27478638	4487176	0	20216017	82523356	102739373	20	83	103
15,5	64182566	40251655	30510214	16787574	2039625	0	64182566	89589068	153771634	64	90	154
16	103212346	64728915	16030790	2670371	0	0	103212346	83430076	186642422	103	83	187
16,5	180265783	113052449	8403237	899799	2039625	4157	180265783	124399267	304665050	180	124	305
17	224806398	140985790	2585611	1797394	0	9699	224806398	145378494	370184892	225	145	370
17,5	397749424	249445822	1680647	897595	0	12471	397749424	252036535	649785959	398	252	650
18	433556757	271902145	1680647	74800	0	33255	433556757	273690847	707247604	434	274	707
18,5	277567598	174074614	904964	37400	0	34641	277567598	175051619	452619217	278	175	453
19	114653751	71904313	0	0	0	52654	114653751	71956967	186610718	115	72	187
19,5	85676860	53731654	0	37400	0	24941	85676860	53793995	139470855	86	54	139
20	51112618	32054928	0	37400	0	38798	51112618	32131126	83243744	51	32	83
20,5	29712232	18633822	0	0	0	9699	29712232	18643521	48355753	30	19	48
21	8284820	5195768	904964	0	0	5543	8284820	6106275	14391095	8	6	14
21,5	2040256	1279533	0	0	0	4157	2040256	1283690	3323946	2	1	3
22	834652	523446	0	0	0	0	834652	523446	1358098	1	1	1
22,5	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	2006271002	1258219090	1174384664	563128974	448717598	230015	2006271002	3444680341	5450951343	**2006**	**3445**	**5451**
Millions	**2006**	**1258**	**1174**	**563**	**449**	**0,2**	**2006**	**3445**	**5451**			

Table 7. *ECOCADIZ-RECLUTAS 2020-10* survey. Sardine (*Sardina pilchardus*). Cont'd.

ECOCADIZ-RECLUTAS 2020-10 . *Sardina pilchardus* . BIOMASS (t)									
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**PORTUGAL**	**SPAIN**	**TOTAL**
6	0	0	0	0	0	0	0	0	0
6,5	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0
7,5	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0
8,5	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0
9,5	0	0	0	0	0	0	0	0	0
10	0	0	242,494	0	0	0	0	242,494	242,494
10,5	0	0	1188,987	0	0	0	0	1188,987	1188,987
11	0	0	2887,893	24,964	0	0	0	2912,857	2912,857
11,5	0	0	2749,264	110,492	122,914	0	0	2982,67	2982,670
12	0	0	2080,779	391,16	1182,79	0	0	3654,729	3654,729
12,5	0	0	625,495	625,557	2818,605	0	0	4069,657	4069,657
13	0	0	675,176	1898,118	1978,758	0	0	4552,052	4552,052
13,5	0	0	1152,79	2975,252	518,460	0	0	4646,502	4646,502
14	54,489	34,172	970,304	2880,406	298,697	0	54,489	4183,579	4238,068
14,5	258,873	162,350	998,906	1296,813	221,371	0	258,873	2679,440	2938,313
15	587,590	368,503	1100,981	798,682	130,422	0	587,590	2398,588	2986,178
15,5	2090,293	1310,913	993,654	546,736	66,426	0	2090,293	2917,729	5008,022
16	3753,086	2353,722	582,924	97,102	0	0	3753,086	3033,748	6786,834
16,5	7294,344	4574,598	340,032	36,410	82,532	0,168	7294,344	5033,740	12328,084
17	10090,956	6328,474	116,061	80,680	0	0,435	10090,956	6525,650	16616,606
17,5	19746,792	12384,065	83,438	44,562	0	0,619	19746,792	12512,684	32259,476
18	23739,988	14888,371	92,026	4,096	0	1,821	23739,988	14986,314	38726,302
18,5	16718,633	10484,976	54,508	2,253	0	2,087	16718,633	10543,824	27262,457
19	7577,540	4752,202	0	0	0	3,480	7577,540	4755,682	12333,222
19,5	6198,374	3887,268	0	2,706	0	1,804	6198,374	3891,778	10090,152
20	4038,636	2532,803	0	2,955	0	3,066	4038,636	2538,824	6577,460
20,5	2558,587	1604,600	0	0	0	0,835	2558,587	1605,435	4164,022
21	775,919	486,613	84,755	0	0	0,519	775,919	571,887	1347,806
21,5	207,414	130,079	0	0	0	0,423	207,414	130,502	337,916
22	91,933	57,655	0	0	0	0	91,933	57,655	149,588
22,5	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0
TOTAL	**105783,447**	**66341,364**	**17020,467**	**11818,944**	**7420,975**	**15,257**	**105783,447**	**102617,007**	**208400,454**

Table 8. *ECOCADIZ-RECLUTAS* surveys series. Sardine (*Sardina pilchardus*). Acoustic estimates of biomass (t) and abundance (million fish) for the whole Gulf of Cadiz anchovy population and for the juvenile fraction (*i.e*. age 0 fish, between parentheses). Age-0 estimates for 2020 not yet available. Note that the 2012 survey only surveyed the Spanish waters. The 2017 estimates correspond to an incomplete coverage (only the seven easternmost transects) of the standard surveyed area due to a research vessels' breakdown.

Estimate/Year	Total Population (Recruits at age 0)							
	2012	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Biomass (t)	22119 (9182)	36571 (705)	30992 (8645)	35173 (21899)	12119 (8778)	20679 (15224)	36465 (7858)	208400 (n.a.)
Abundance (millions)	603 (359)	507 (26)	861 (509)	2379 (1940)	591 (483)	1134 (1036)	937 (384)	5451 (n.a.)

Table 9. *ECOCADIZ-RECLUTAS 2019-10* survey. Chub mackerel (*Scomber colias*). Estimated abundance (absolute numbers and million fish) and biomass (t) by size class (in cm). Polygons (*i.e.*, coherent or homogeneous post-strata) numbered as in **Figure 18**.

ECOCADIZ-RECLUTAS 2020-10 . *Scomber colias* . ABUNDANCE (in numbers and million fish)													
Size class	POL01	POL02	POL03	POL04	POL05	POL06	POL07	*n*			Millions		
								PORTUGAL	SPAIN	TOTAL	PORTUGAL	SPAIN	TOTAL
14	0	0	0	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0
15,5	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0
16,5	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0
17,5	0	0	431902	0	110977	191270	0	431902	302247	734149	0,4	0,3	1
18	0	0	1678804	0	431370	908532	0	1678804	1339902	3018706	2	1	3
18,5	0	0	6912766	154801	1776240	1577976	7656	6912766	3516673	10429439	7	4	10
19	0	0	13162928	158976	3382224	1625794	7862	13162928	5174856	18337784	13	5	18
19,5	0	426413	20557902	216141	5282368	1291071	10689	20984315	6800269	27784584	21	7	28
20	0	1722539	23991438	480181	6164618	334722	23748	25713977	7003269	32717246	26	7	33
20,5	0	1727449	17680313	803559	4542970	143452	39741	19407762	5529722	24937484	19	6	25
21	0	3948213	12947122	1599676	3326772	143452	79113	16895335	5149013	22044348	17	5	22
21,5	0	9487583	10636239	2565111	2732989	95635	126859	20123822	5520594	25644416	20	6	26
22	0	13153135	10697070	4782212	2748620	0	236508	23850205	7767340	31617545	24	8	32
22,5	222916	15218695	7989236	5566213	2052840	47817	275281	23430847	7942151	31372998	23	8	31
23	140789	9310226	7830670	6225946	2012096	0	307909	17281685	8545951	25827636	17	9	26
23,5	527958	2934030	6916904	3757105	1777304	0	185810	10378892	5720219	16099111	10	6	16
24	668747	2450464	2859236	3022665	734683	0	149488	5978447	3906836	9885283	6	4	10
24,5	1138044	544503	1152104	1591742	296034	0	78721	2834651	1966497	4801148	3	2	5
25	774339	106015	1578630	1269963	405630	0	62807	2458984	1738400	4197384	2	2	4
25,5	750874	220864	1004172	154801	258023	0	7656	1975910	420480	2396390	2	0,4	2
26	727409	106015	431320	211966	110828	0	10483	1264744	333277	1598021	1	0,3	2
26,5	445832	0	0	217226	0	0	10743	445832	227969	673801	0,4	0,2	1
27	164254	0	0	160061	0	0	7916	164254	167977	332231	0,2	0,2	0,3
27,5	58662	0	0	0	0	0	0	58662	0	58662	0,1	0	0,1
28	0	0	151193	0	38849	0	0	151193	38849	190042	0,2	0,04	0,2
28,5	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0
32,5	0	0	0	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0
33,5	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0
34,5	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	57165	0	0	2827	0	59992	59992	0	0,1	0,1
35,5	0	0	0	57165	0	0	2827	0	59992	59992	0	0,1	0,1
36	0	0	0	57165	0	0	2827	0	59992	59992	0	0,1	0,1
36,5	0	0	0	57165	0	0	2827	0	59992	59992	0	0,1	0,1
37	0	0	0	0	0	0	0	0	0	0	0	0	0
37,5	0	0	0	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL *n*	5619824	61356144	148609949	33167005	38185435	6359721	1640298	215585917	79352459	294938376	**216**	**79**	**295**
Millions	**6**	**61**	**149**	**33**	**38**	**6**	**2**						

Table 9. *ECOCADIZ-RECLUTAS 2019-10* survey. Chub mackerel (*Scomber colias*). Cont'd.

ECOCADIZ-RECLUTAS 2020-10 . Scomber colias . BIOMASS (t)										
Size class	**POL01**	**POL02**	**POL03**	**POL04**	**POL05**	**POL06**	**POL07**	**PORTUGAL**	**SPAIN**	**TOTAL**
14	0	0	0	0	0	0	0	0	0	0
14,5	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0
15,5	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0
16,5	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0
17,5	0	0	16,905	0	4,344	7,487	0	16,905	11,831	28,736
18	0	0	72,071	0	18,519	39,003	0	72,071	57,522	129,593
18,5	0	0	324,673	7,271	83,425	74,113	0,360	324,673	165,169	489,842
19	0	0	674,768	8,150	173,382	83,343	0,403	674,768	265,278	940,046
19,5	0	23,805	1147,66	12,066	294,892	72,075	0,597	1171,465	379,630	1551,095
20	0	104,499	1455,451	29,130	373,979	20,306	1,441	1559,95	424,856	1984,806
20,5	0	113,651	1163,208	52,867	298,887	9,438	2,615	1276,859	363,807	1640,666
21	0	281,161	921,994	113,917	236,907	10,216	5,634	1203,155	366,674	1569,829
21,5	0	729,958	818,333	197,355	210,271	7,358	9,760	1548,291	424,744	1973,035
22	0	1091,429	887,628	396,821	228,077	0	19,625	1979,057	644,523	2623,580
22,5	19,916	1359,685	713,783	497,303	183,407	4,272	24,594	2093,384	709,576	2802,96
23	13,522	894,166	752,067	597,948	193,244	0	29,572	1659,755	820,764	2480,519
23,5	54,423	302,448	713,014	387,293	183,21	0	19,154	1069,885	589,657	1659,542
24	73,882	270,722	315,882	333,937	81,166	0	16,515	660,486	431,618	1092,104
24,5	134,558	64,380	136,220	188,201	35,002	0	9,308	335,158	232,511	567,669
25	97,851	13,397	199,487	160,482	51,258	0	7,937	310,735	219,677	530,412
25,5	101,279	29,791	135,444	20,880	34,803	0	1,033	266,514	56,716	323,230
26	104,594	15,244	62,019	30,478	15,936	0	1,507	181,857	47,921	229,778
26,5	68,257	0	0	33,257	0	0	1,645	68,257	34,902	103,159
27	26,745	0	0	26,062	0	0	1,289	26,745	27,351	54,096
27,5	10,147	0	0	0	0	0	0	10,147	0	10,147
28	0	0	27,753	0	7,131	0	0	27,753	7,131	34,884
28,5	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0
29,5	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0
30,5	0	0	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0
31,5	0	0	0	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0
32,5	0	0	0	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0
33,5	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0
34,5	0	0	0	0	0	0	0	0	0	0
35	0	0	0	21,908	0	0	1,083	0	22,991	22,991
35,5	0	0	0	22,959	0	0	1,135	0	24,094	24,094
36	0	0	0	24,044	0	0	1,189	0	25,233	25,233
36,5	0	0	0	25,165	0	0	1,244	0	26,409	26,409
37	0	0	0	0	0	0	0	0	0	0
37,5	0	0	0	0	0	0	0	0	0	0
38	0	0	0	0	0	0	0	0	0	0
TOTAL	**705,174**	**5294,336**	**10538,360**	**3187,494**	**2707,840**	**327,611**	**157,640**	**16537,870**	**6380,585**	**22918,455**

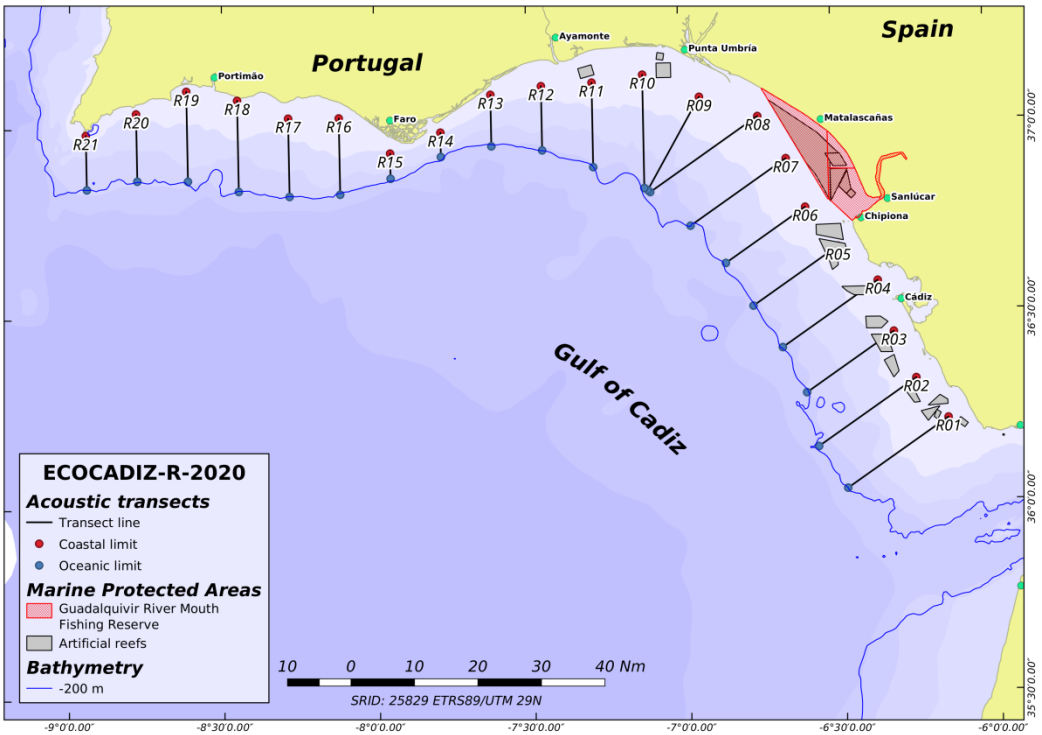

Figure 1. *ECOCADIZ-RECLUTAS 2020-10* survey. Location of the acoustic transects sampled during the survey. The different protected areas inside the Guadalquivir river mouth Fishing Reserve and artificial reef polygons are also shown.

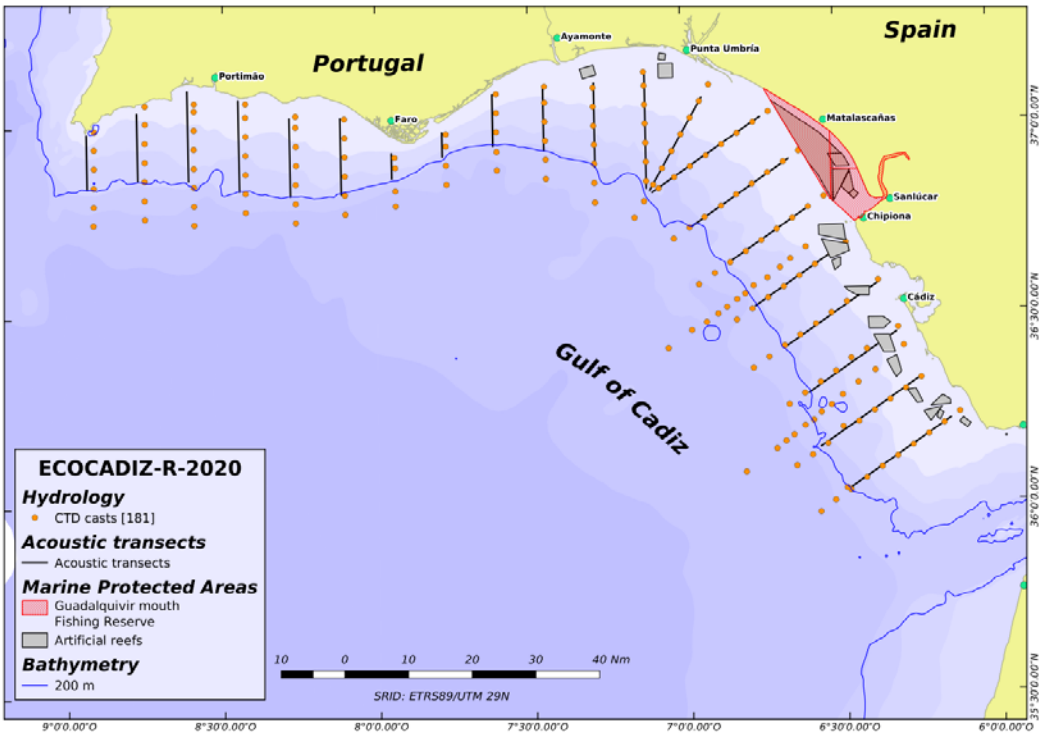

Figure 2. *ECOCADIZ-RECLUTAS 2020-10* survey. Location of CTD stations.

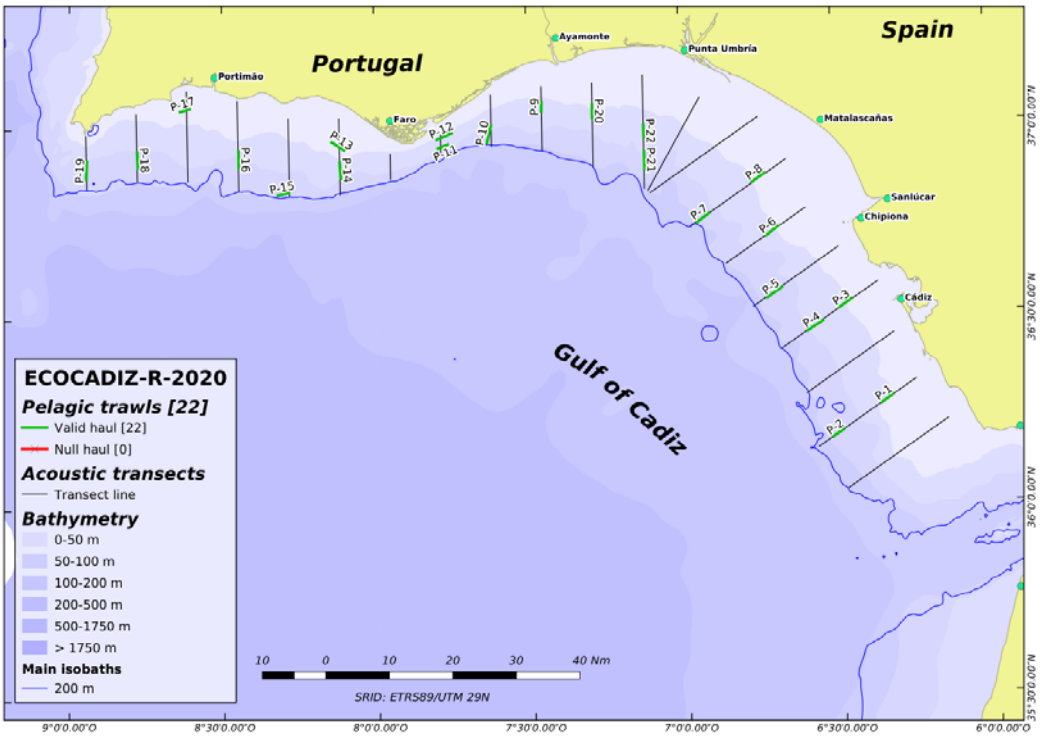

Figure 3. *ECOCADIZ-RECLUTAS 2020-10* survey. Location of ground-truthing fishing hauls.

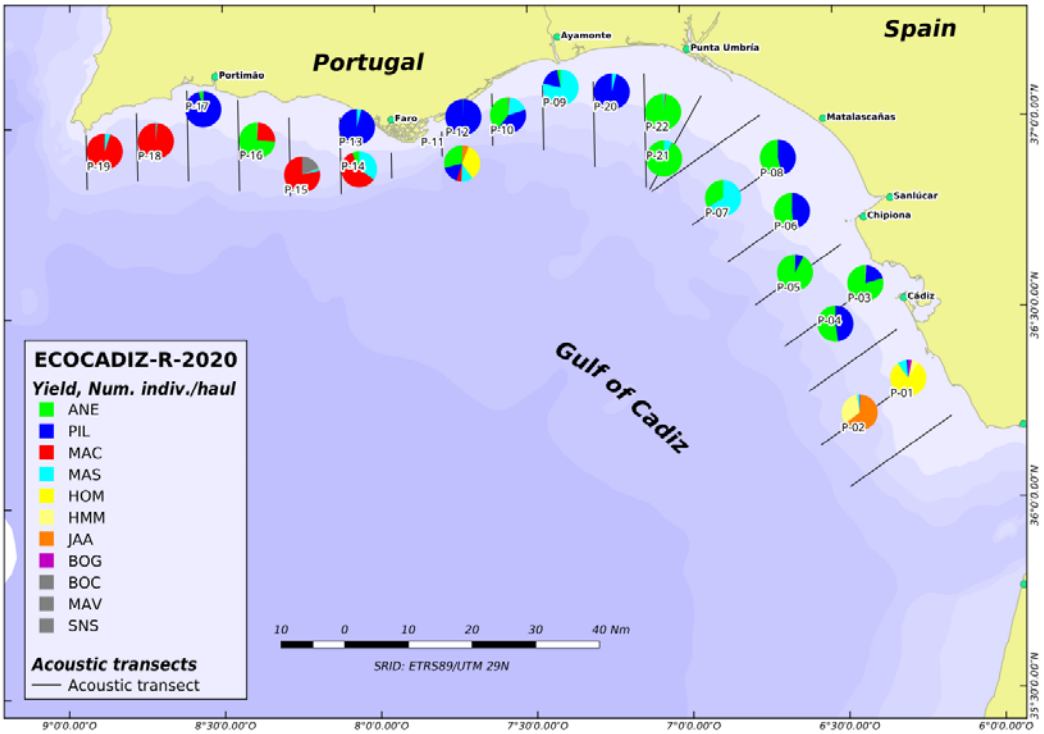

Figure 4. *ECOCADIZ-RECLUTAS 2020-10* survey. Species composition (percentages in number) in valid fishing hauls.

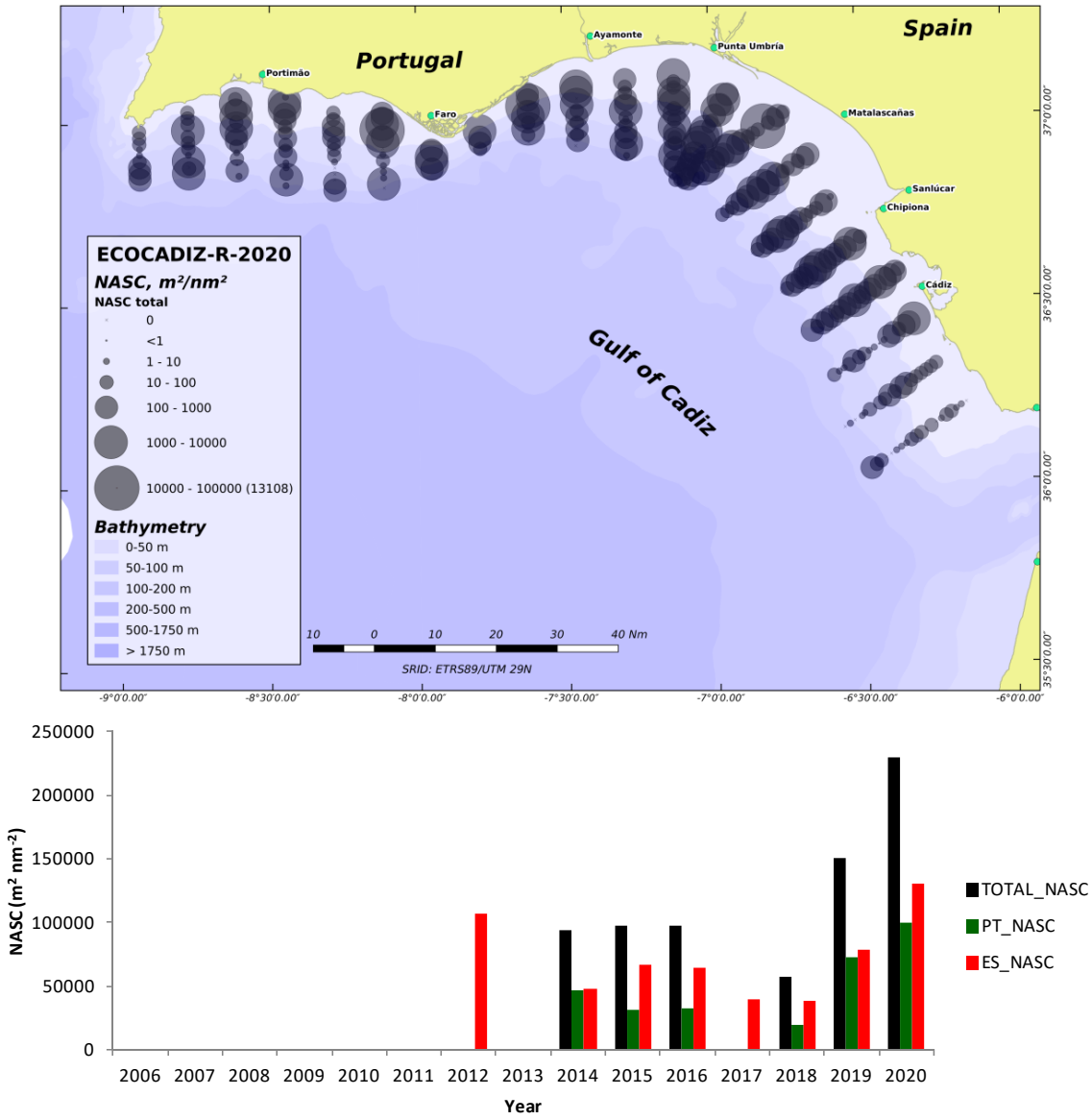

Figure 5. *ECOCADIZ-RECLUTAS 2020-10* survey. Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the pelagic fish species assemblage.

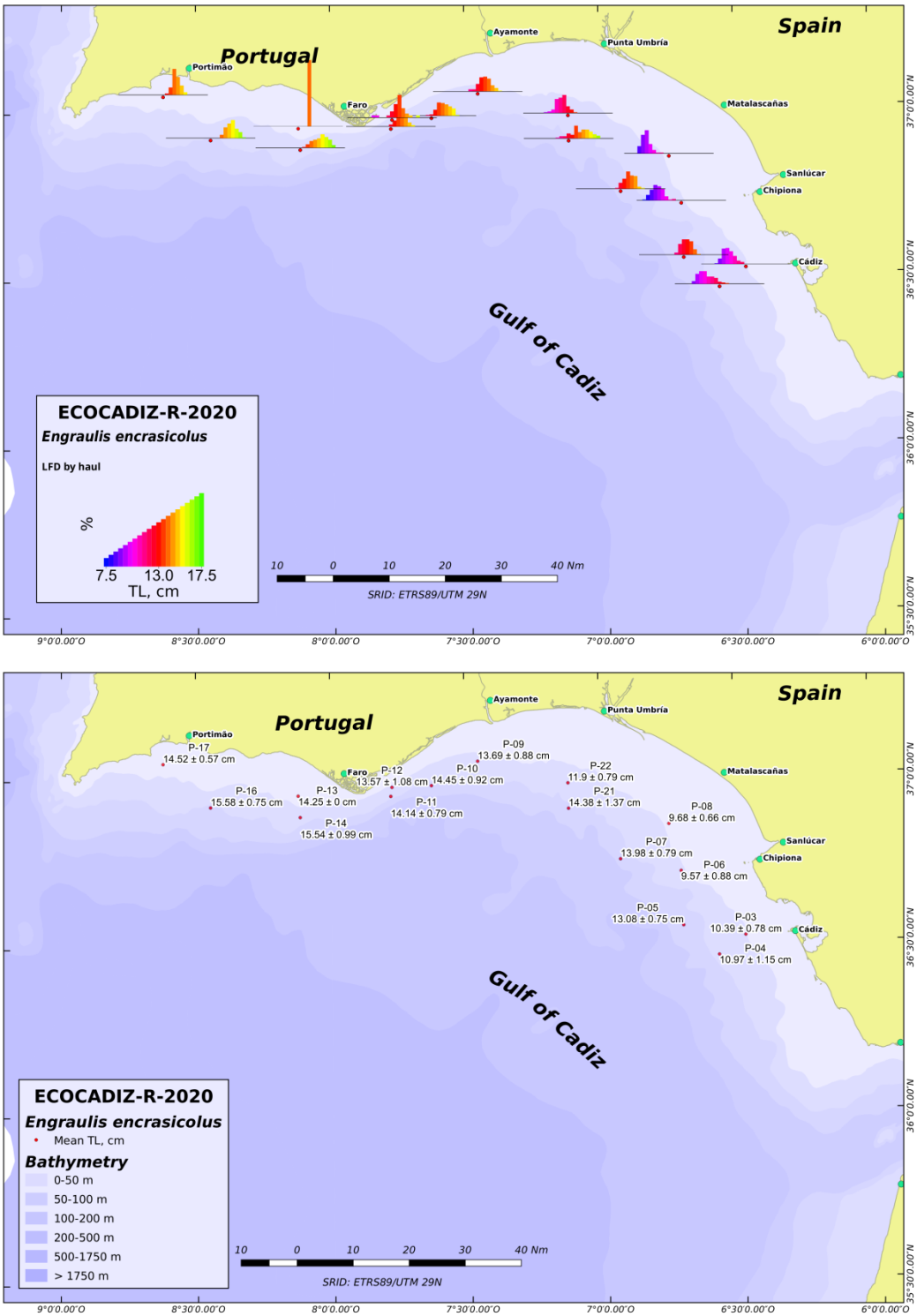

Figure 6. *ECOCADIZ-RECLUTAS 2020-10* survey. Anchovy (*Engraulis encrasicolus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

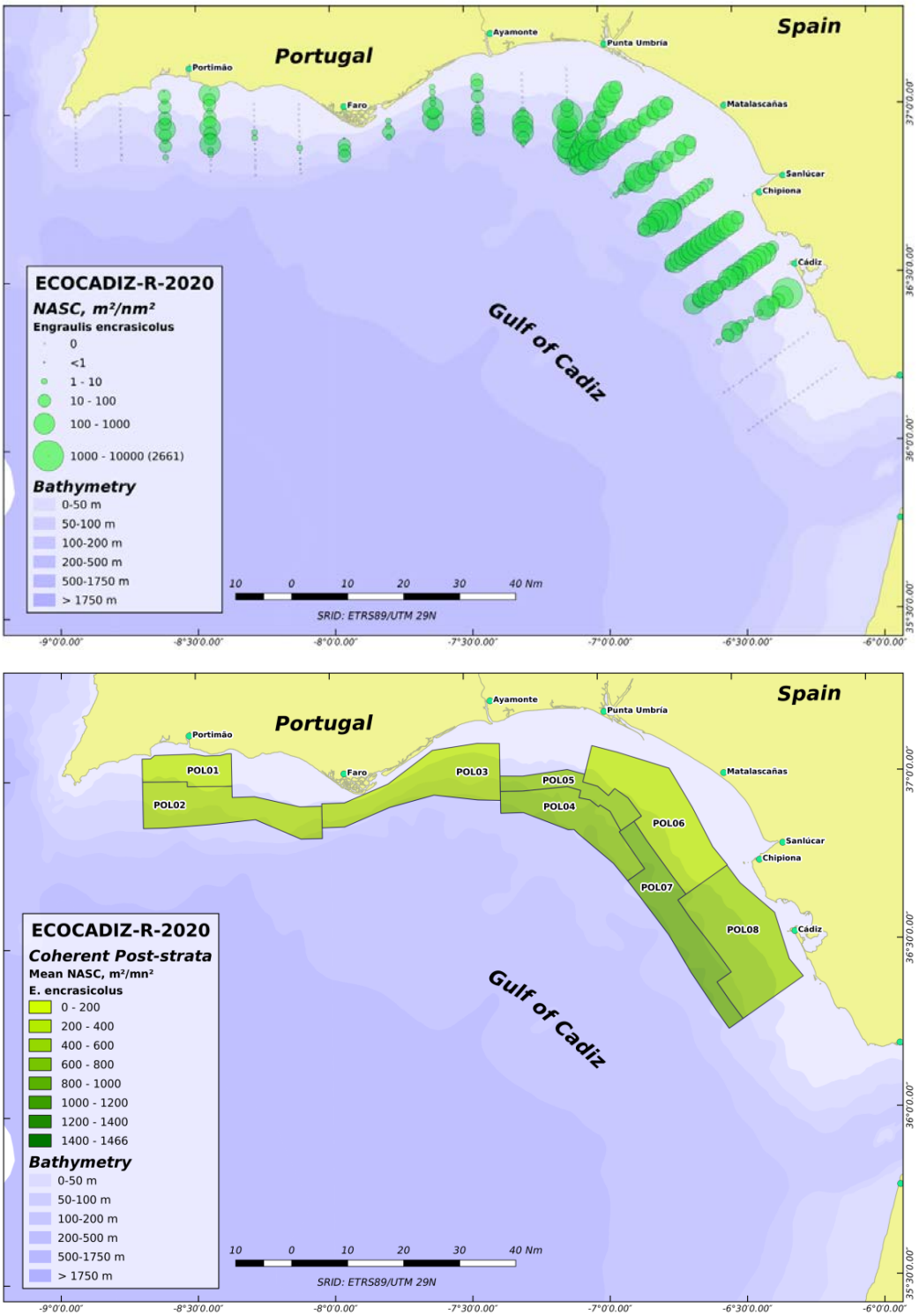

Figure 7. *ECOCADIZ-RECLUTAS 2020-10* survey. Anchovy (*Engraulis encrasicolus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

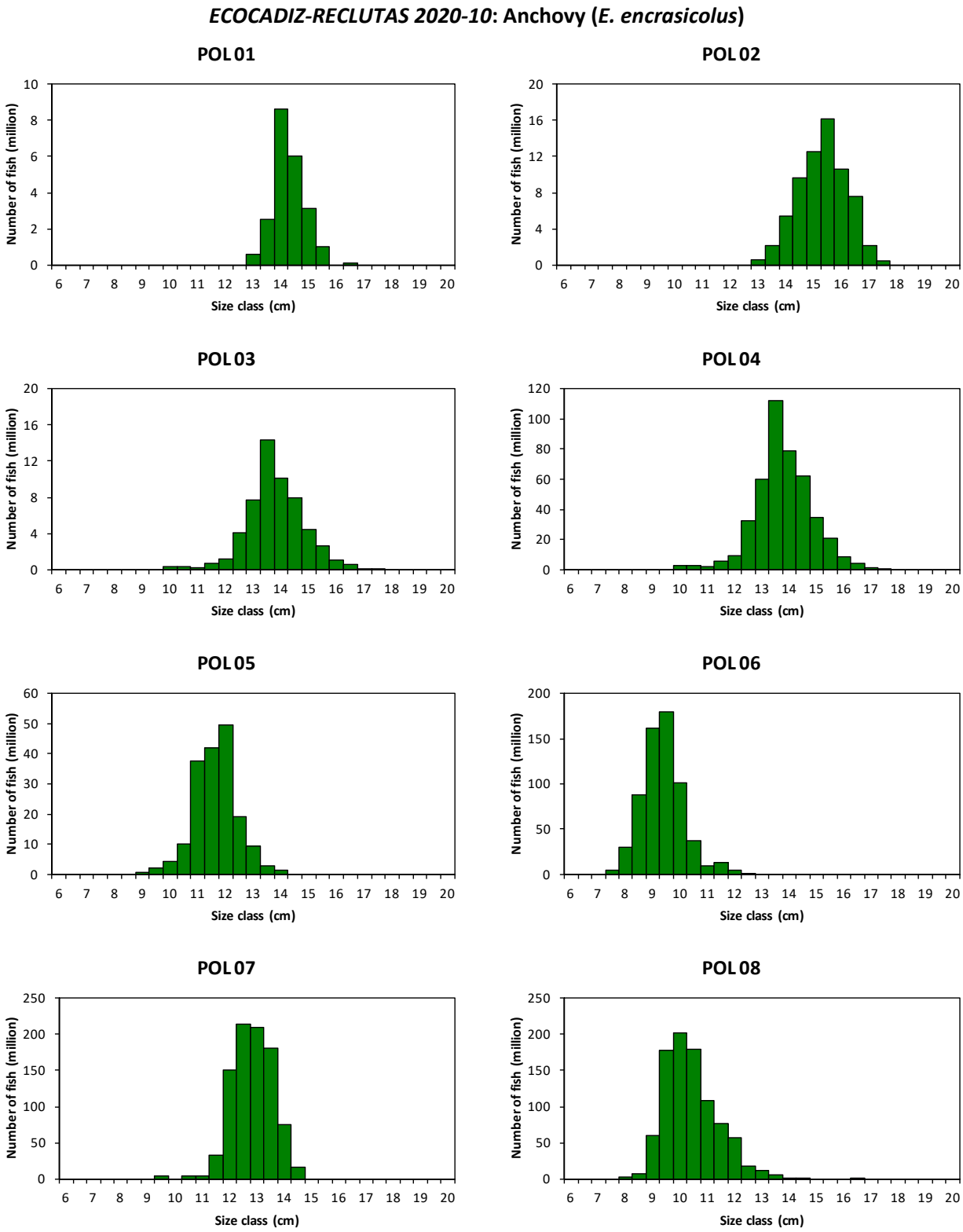

Figure 8. *ECOCADIZ-RECLUTAS 2020-10* survey. Anchovy (*Engraulis encrasicolus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 7**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

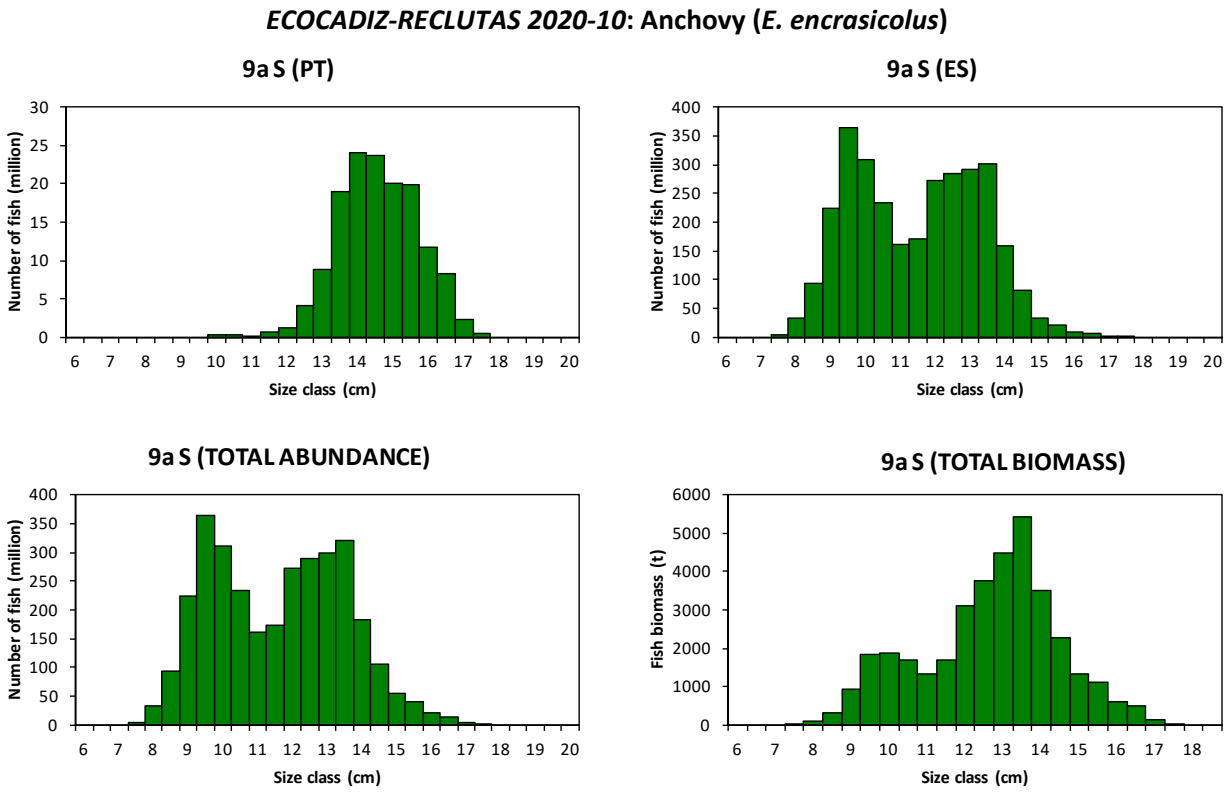

Figure 8. *ECOCADIZ-RECLUTAS 2020-10* survey. Anchovy (*Engraulis encrasicolus*). Cont'd.

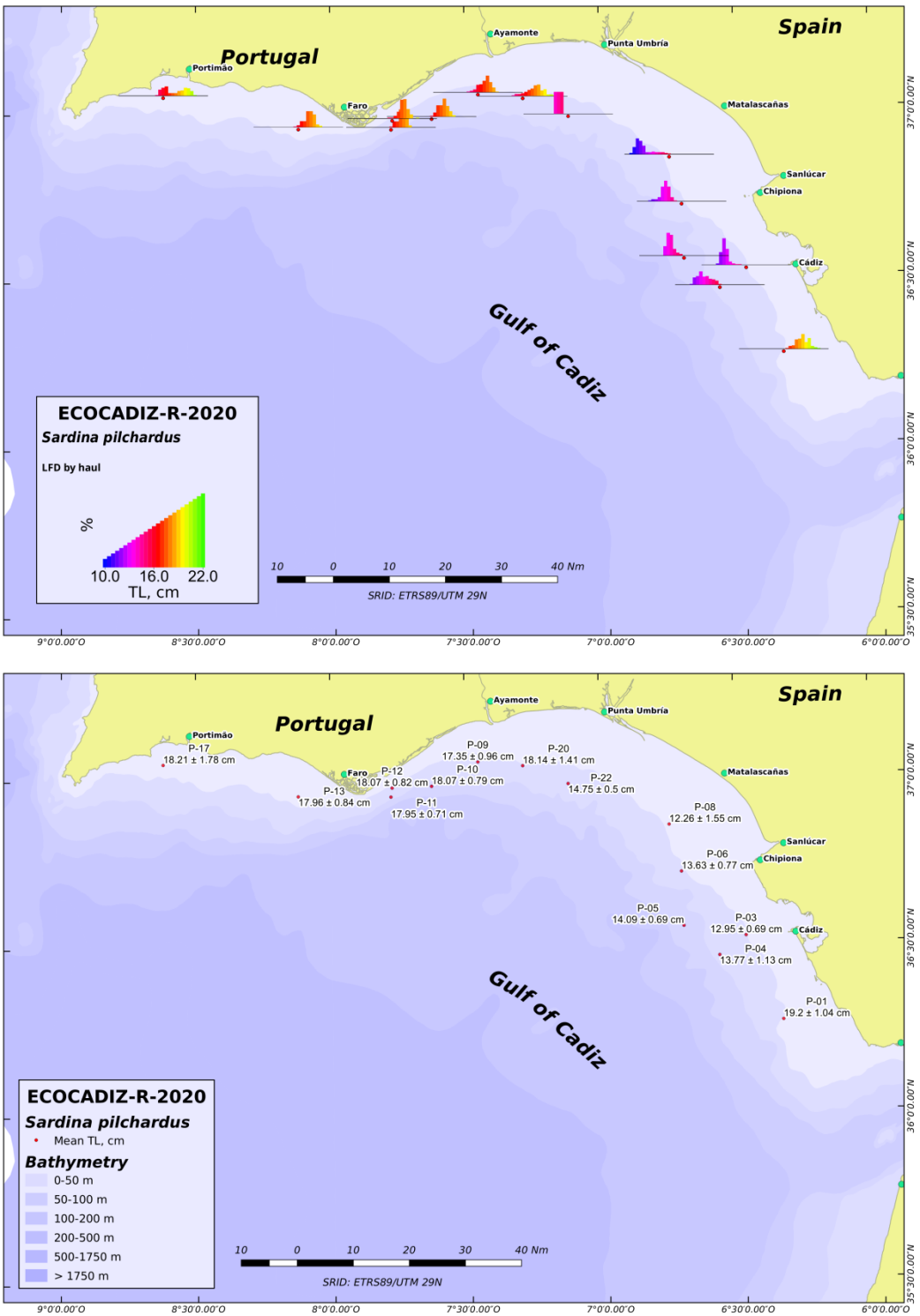

Figure 9. *ECOCADIZ-RECLUTAS 2020-10* survey. Sardine (*Sardina pilchardus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

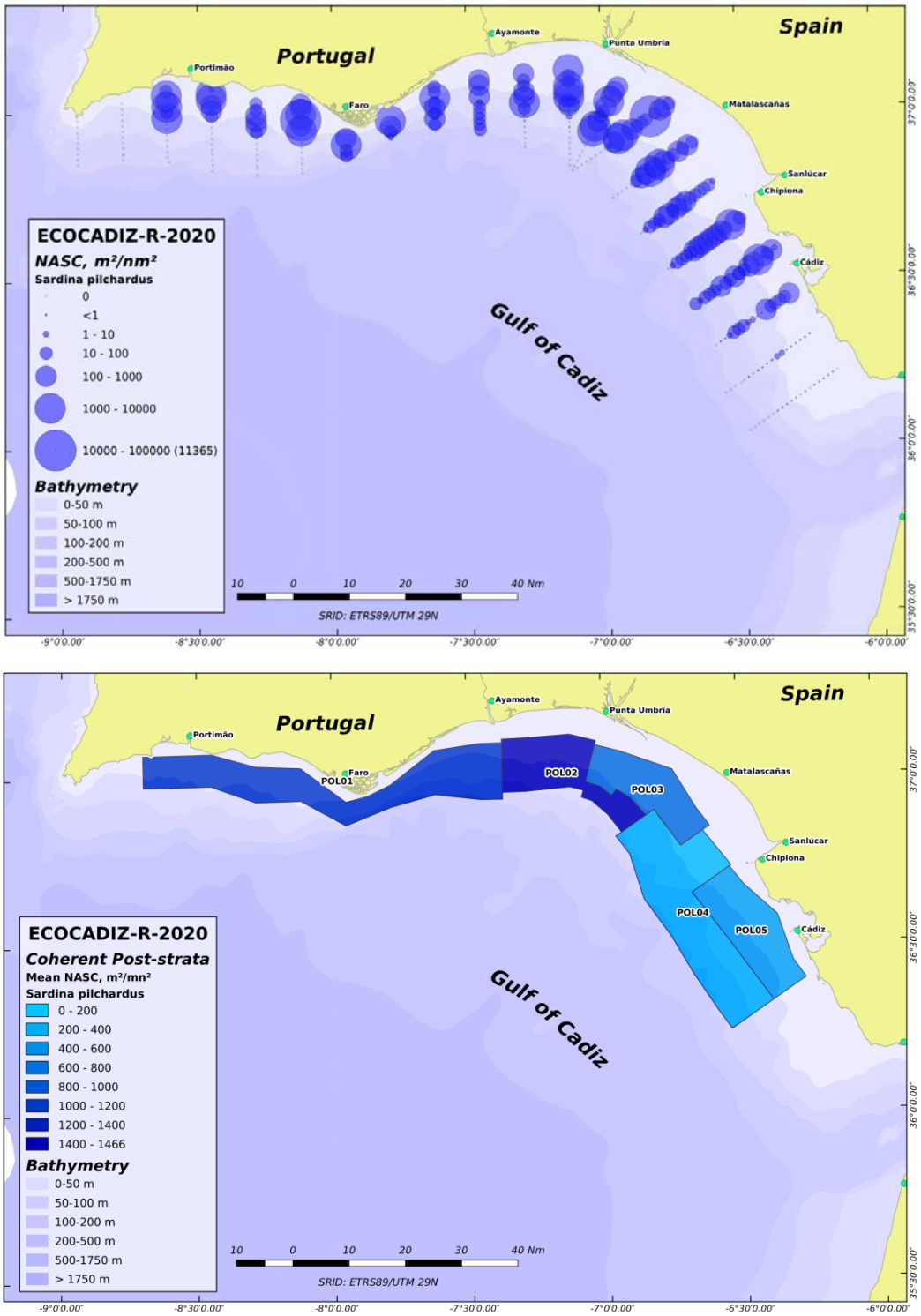

Figure 10. *ECOCADIZ-RECLUTAS 2020-10* survey. Sardine (*Sardina pilchardus*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

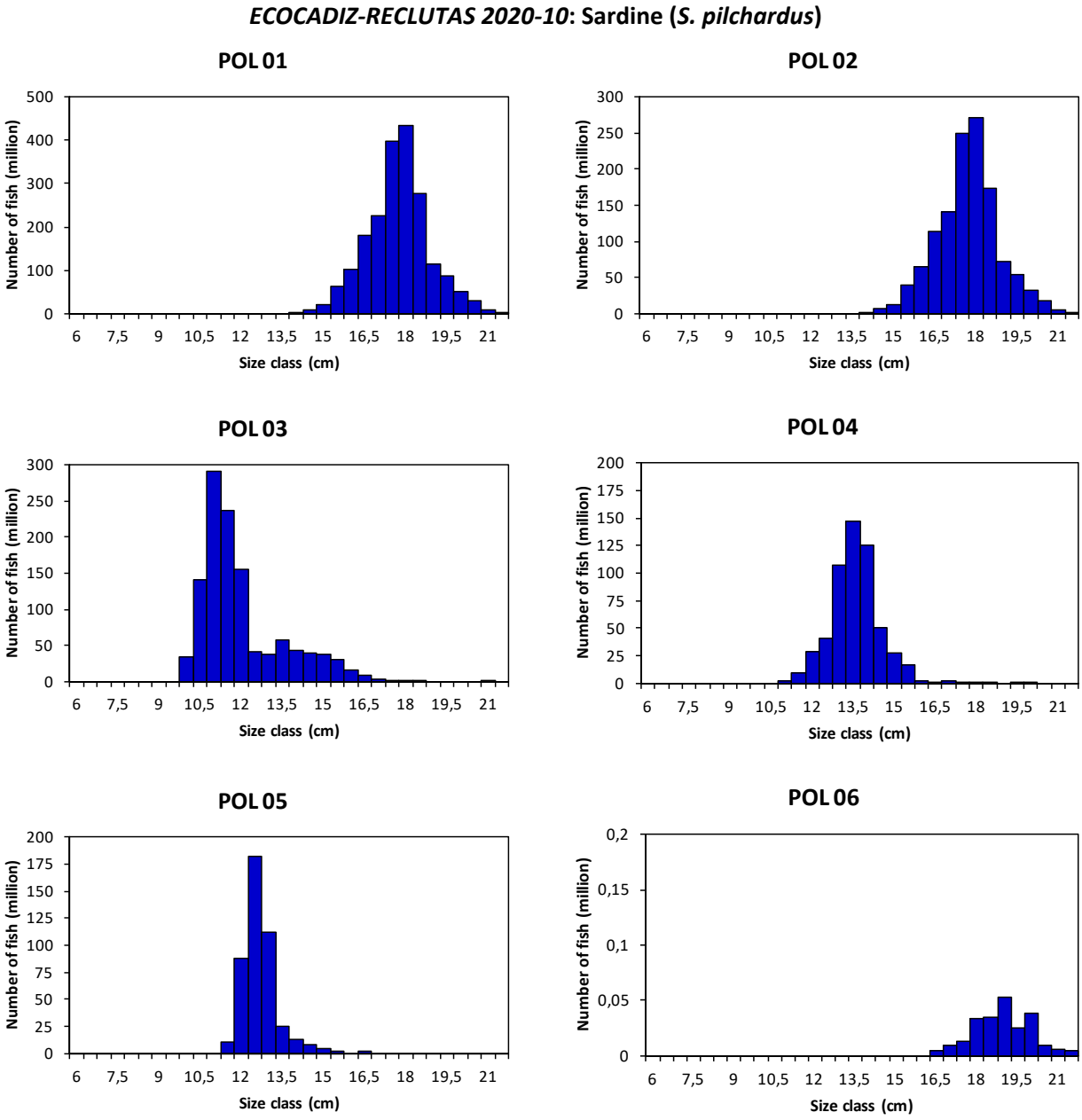

Figure 11. *ECOCADIZ-RECLUTAS 2020-10* survey. Sardine (*Sardina pilchardus*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 10**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

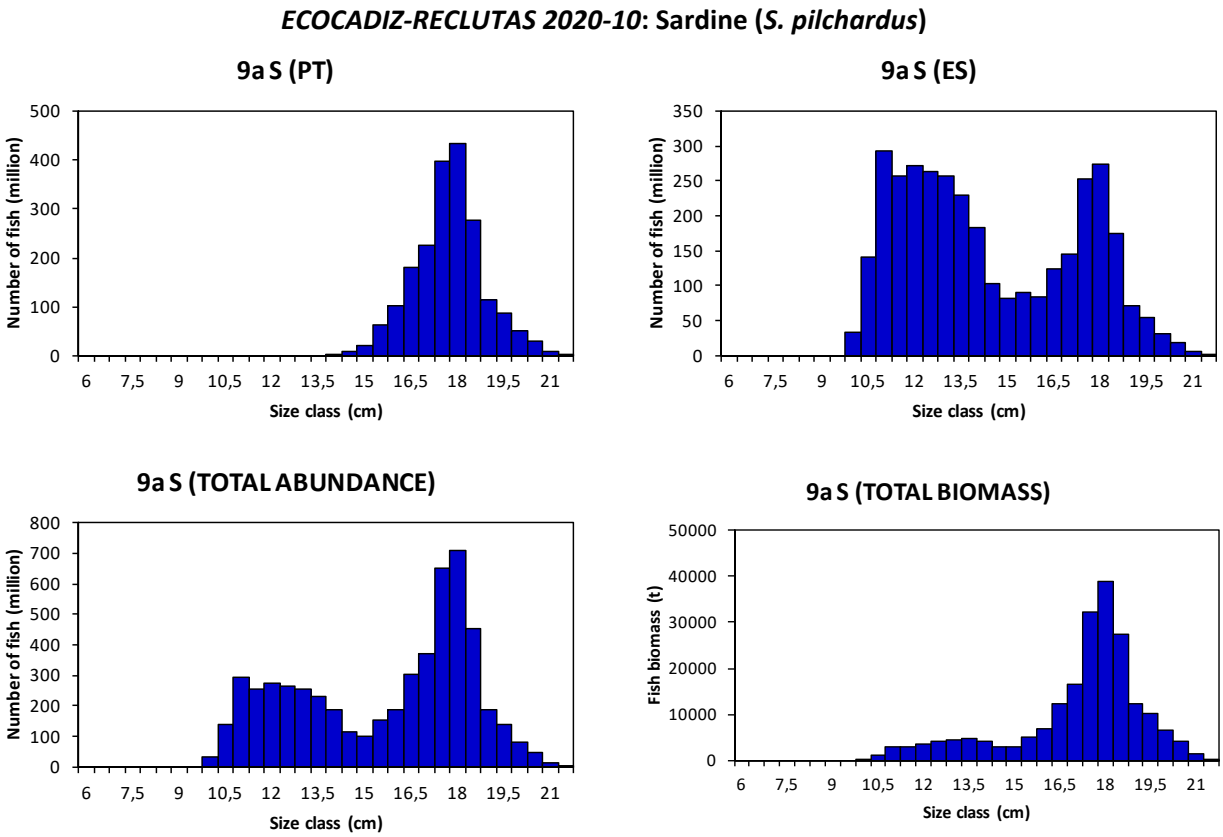

Figure 11. *ECOCADIZ-RECLUTAS 2020-10* survey. Sardine (*Sardina pilchardus*). Cont'd.

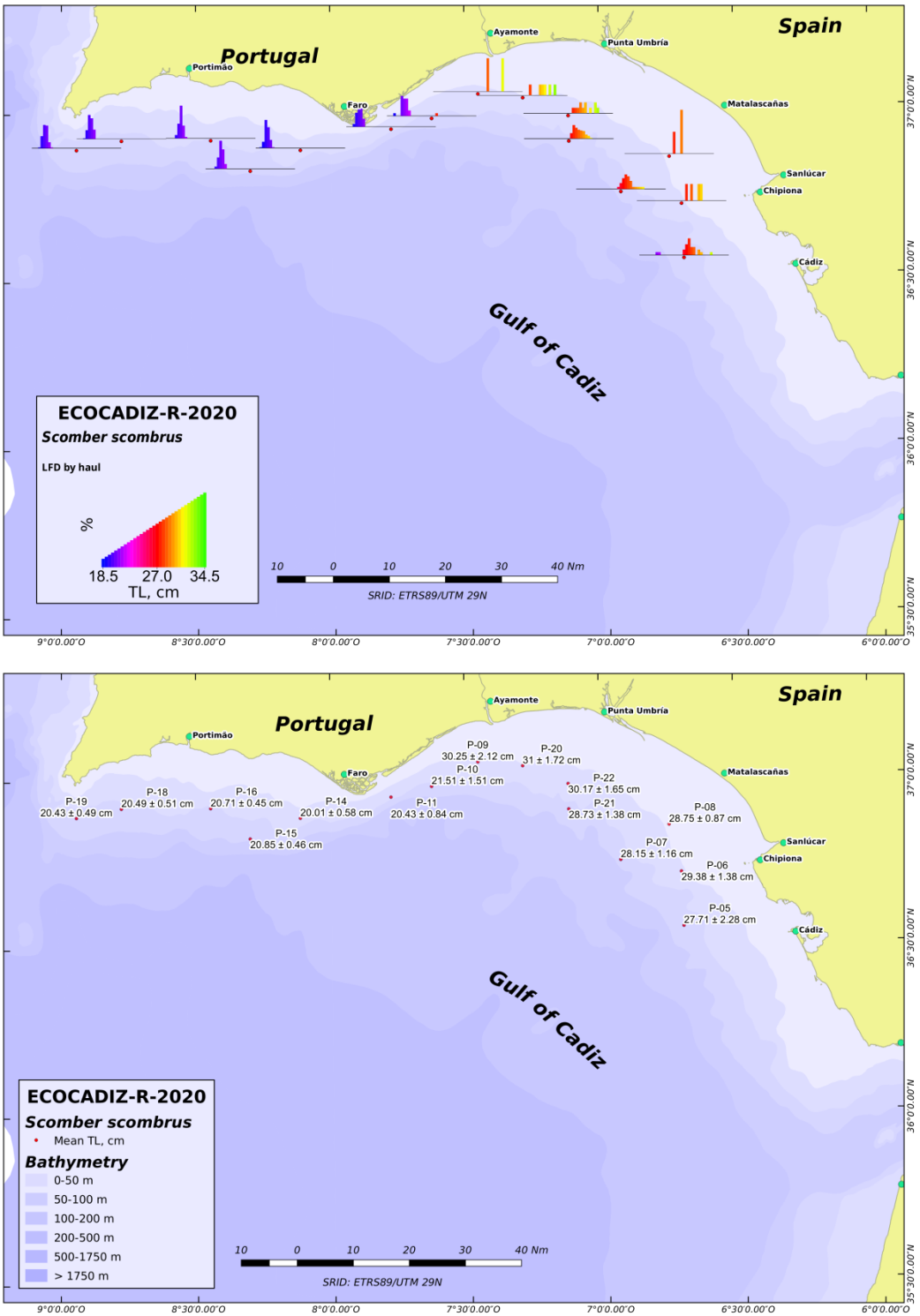

Figure 12. *ECOCADIZ-RECLUTAS 2020-10* survey. Atlantic mackerel (*Scomber scombrus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

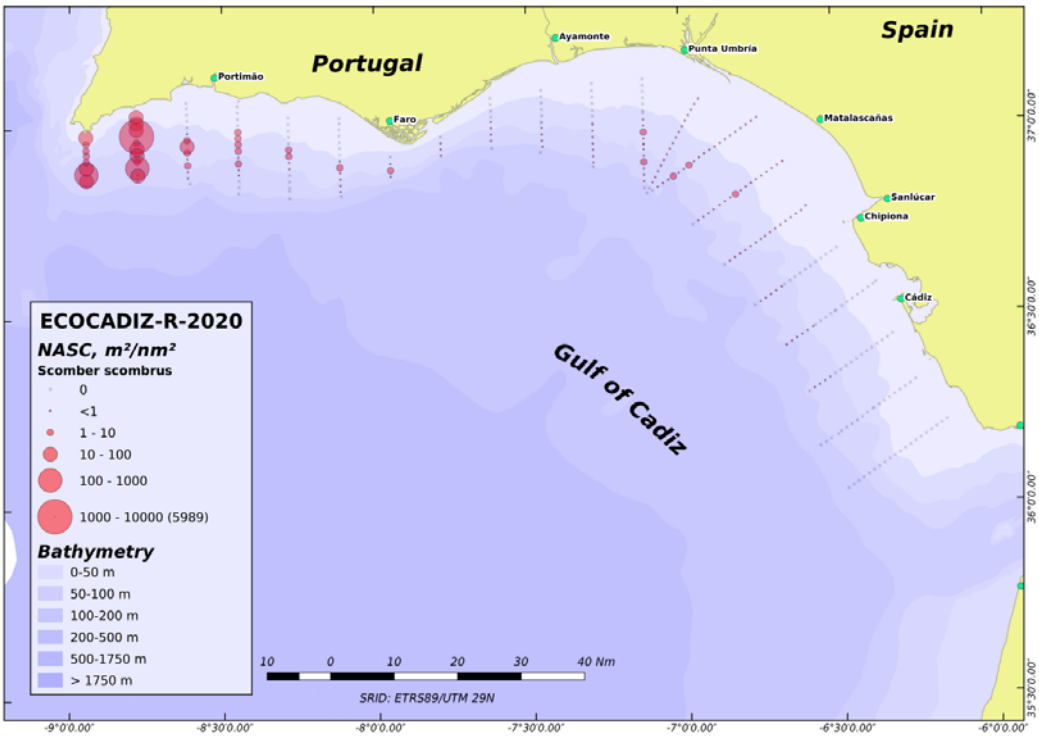

Figure 13. *ECOCADIZ-RECLUTAS 2020-10* survey. Atlantic mackerel (*Scomber scombrus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

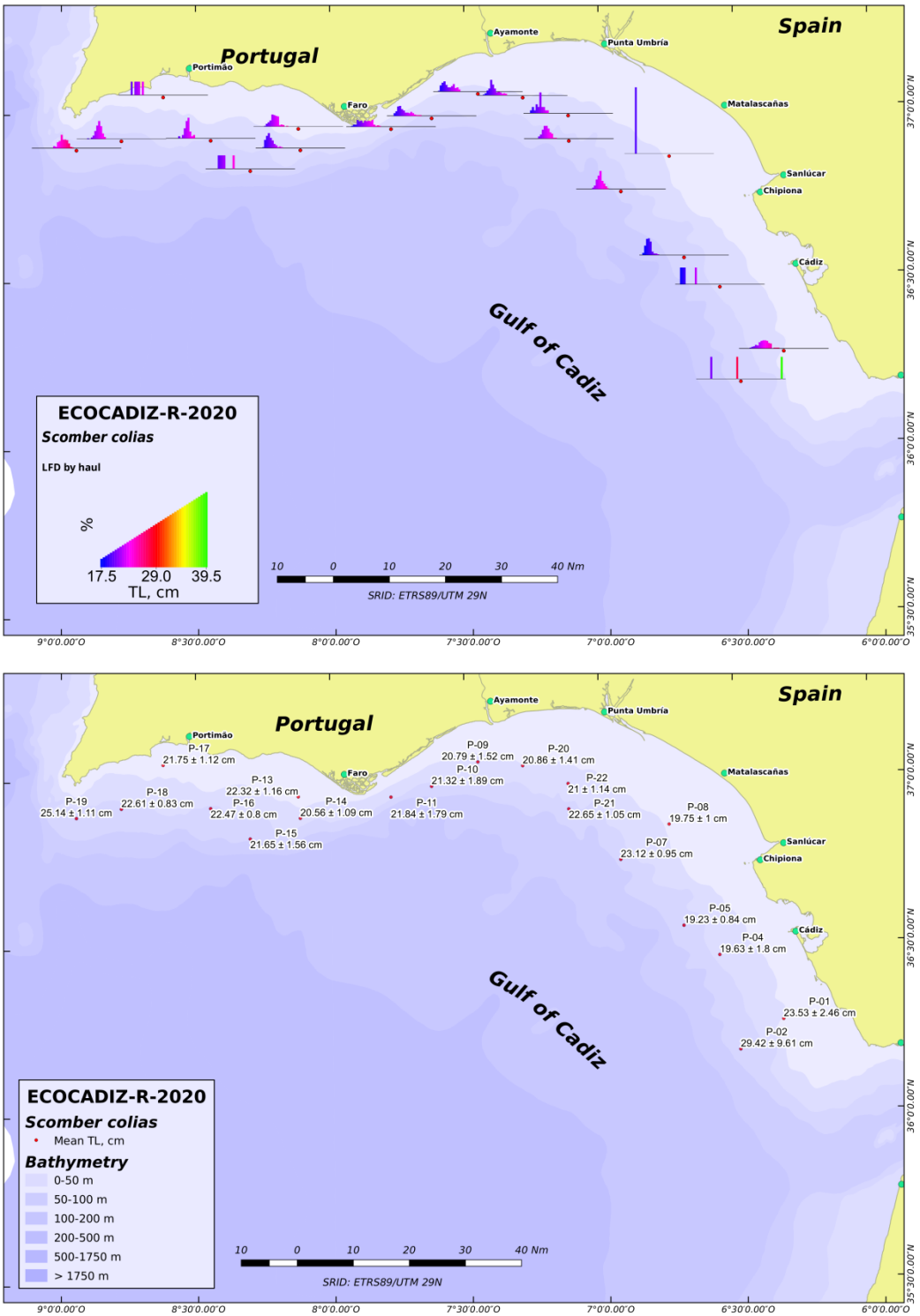

Figure 14. *ECOCADIZ-RECLUTAS 2020-10* survey. Chub mackerel (*Scomber colias*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

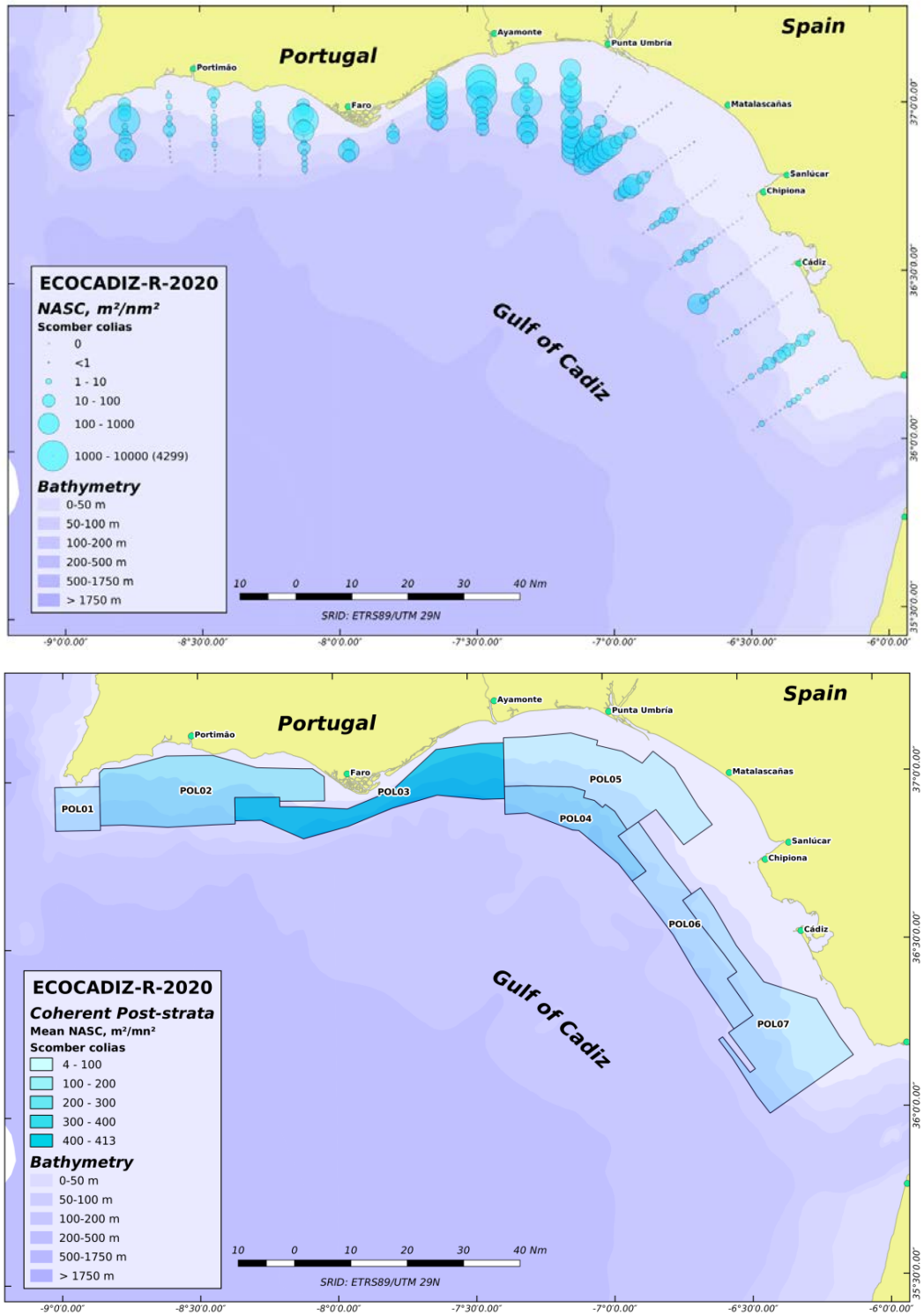

Figure 15. *ECOCADIZ-RECLUTAS 2020-10* survey. Chub mackerel (*Scomber colias*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

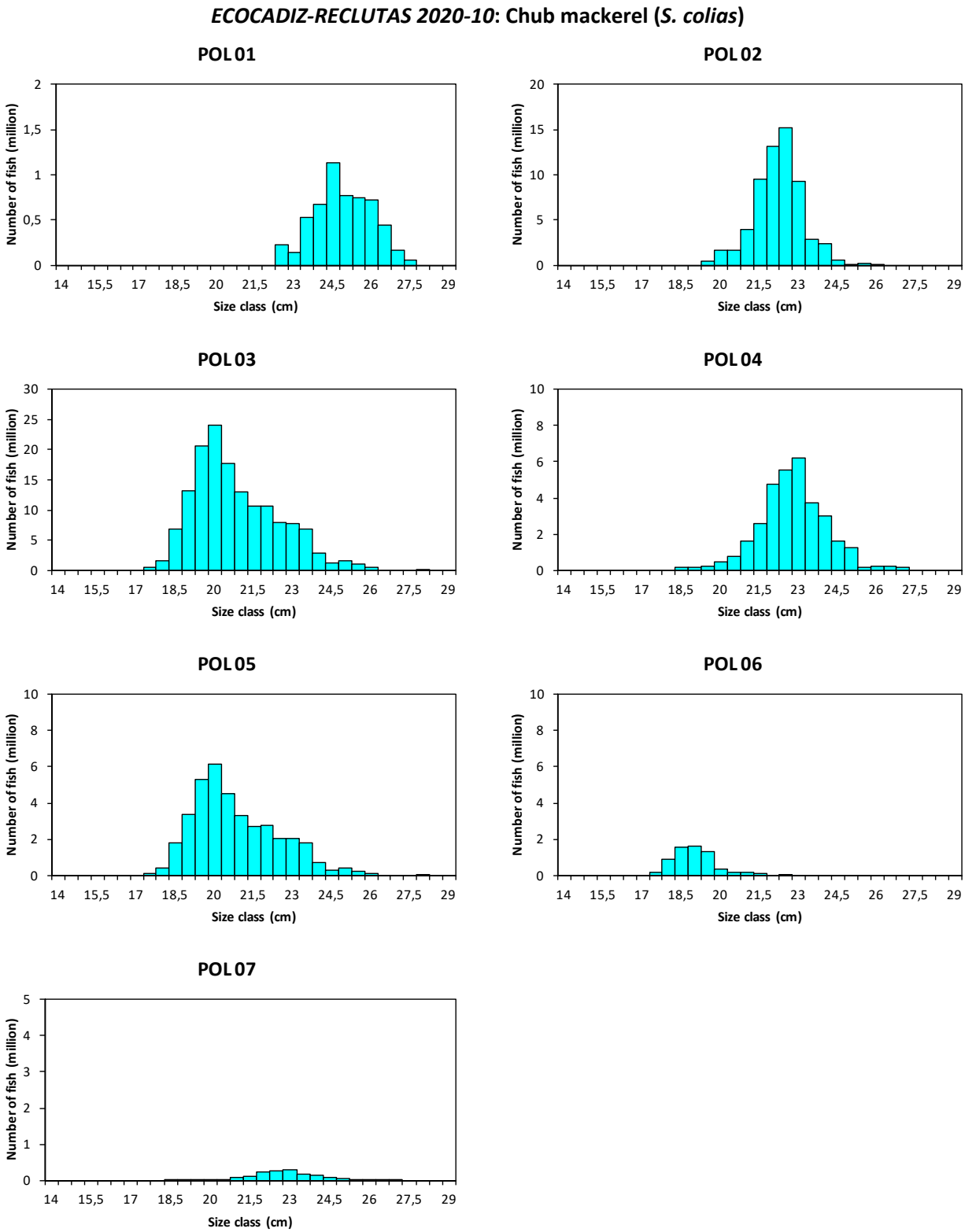

Figure 16. *ECOCADIZ-RECLUTAS 2020-10* survey. Chub mackerel (*Scomber colias*). Estimated abundances (number of fish in millions) by length class (cm) by homogeneous stratum (POL01-POLn, numeration as in **Figure 15**) and total sampled area. Post-strata ordered in the W-E direction. The estimated biomass (t) by size class for the whole sampled area is also shown for comparison. Note the different scales in the y axis.

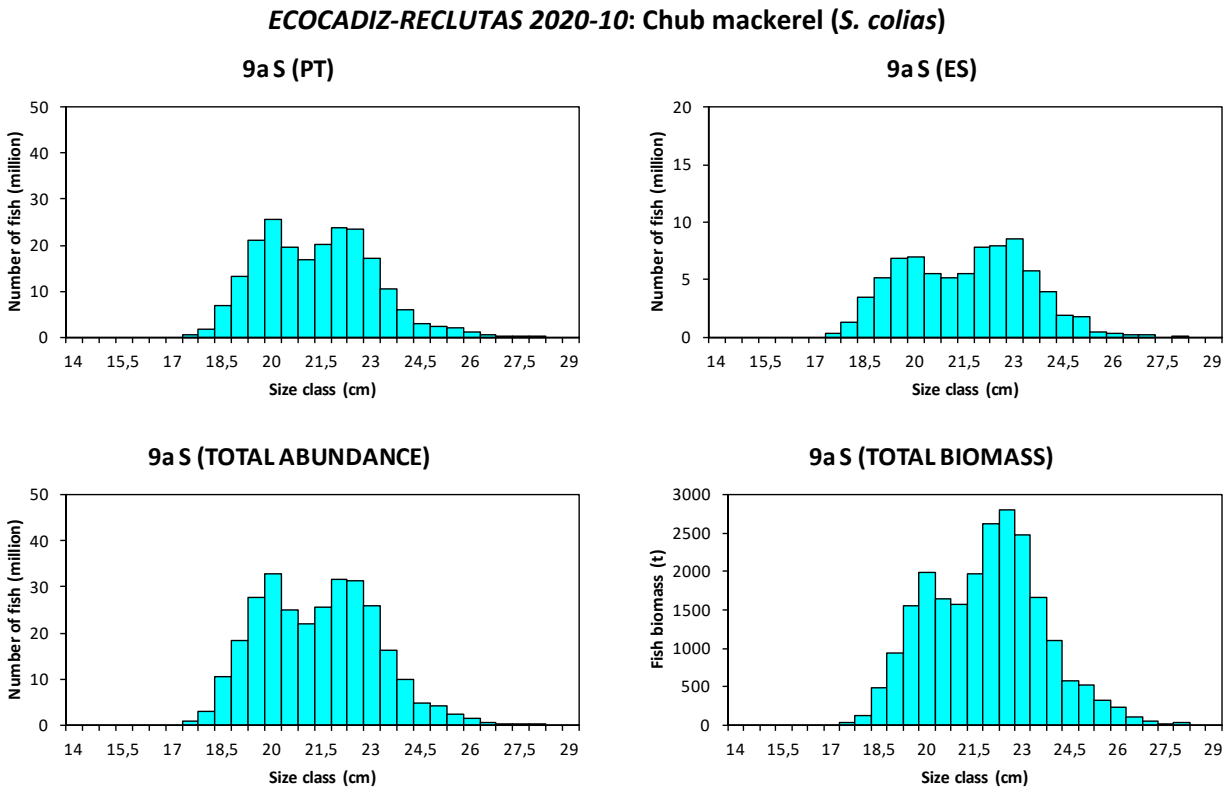

Figure 16. *ECOCADIZ-RECLUTAS 2020-10* survey. Chub mackerel (*Scomber colias*). Cont'd.

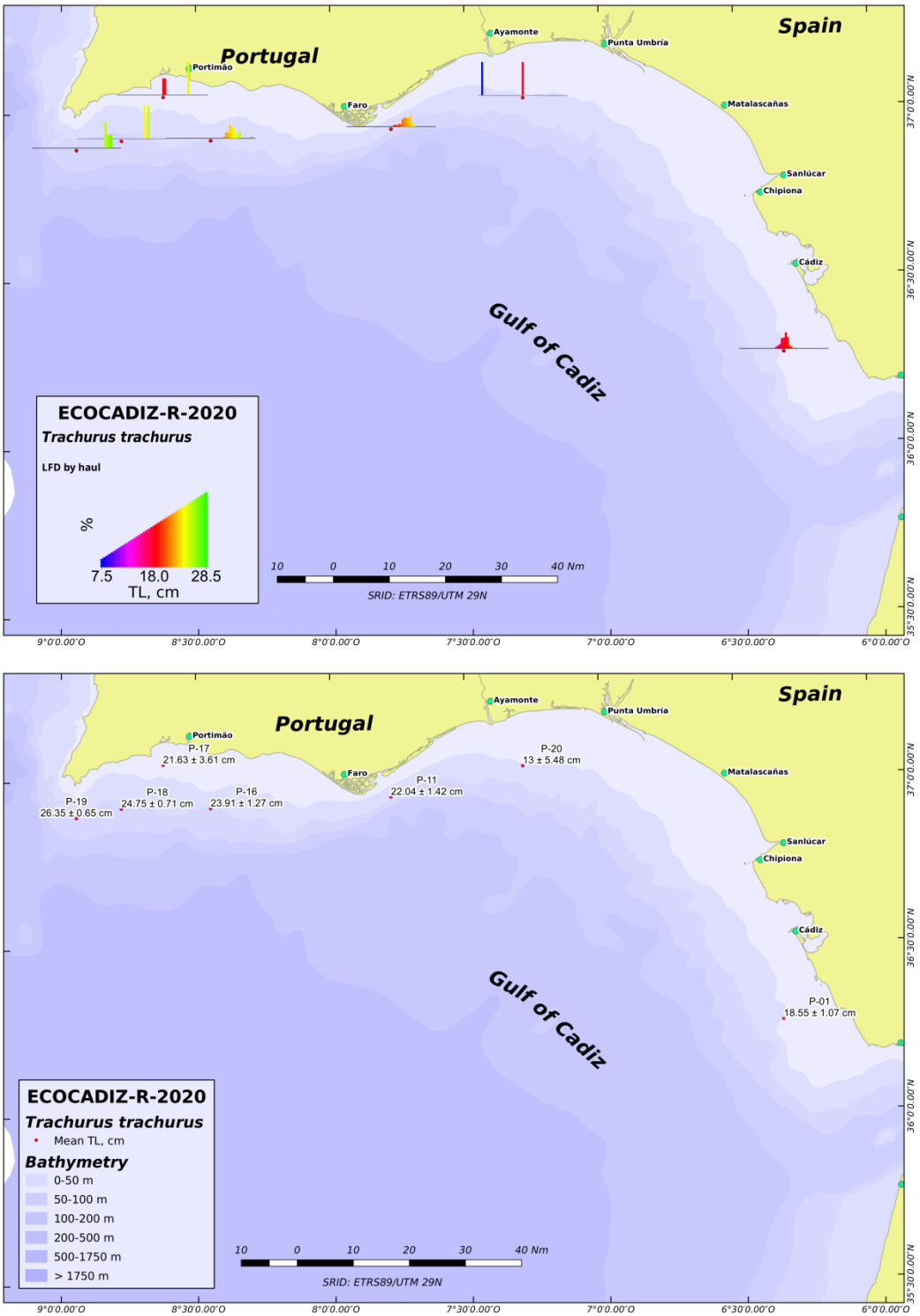

Figure 17. *ECOCADIZ-RECLUTAS 2020-10* survey. Horse mackerel (*Trachurus trachurus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

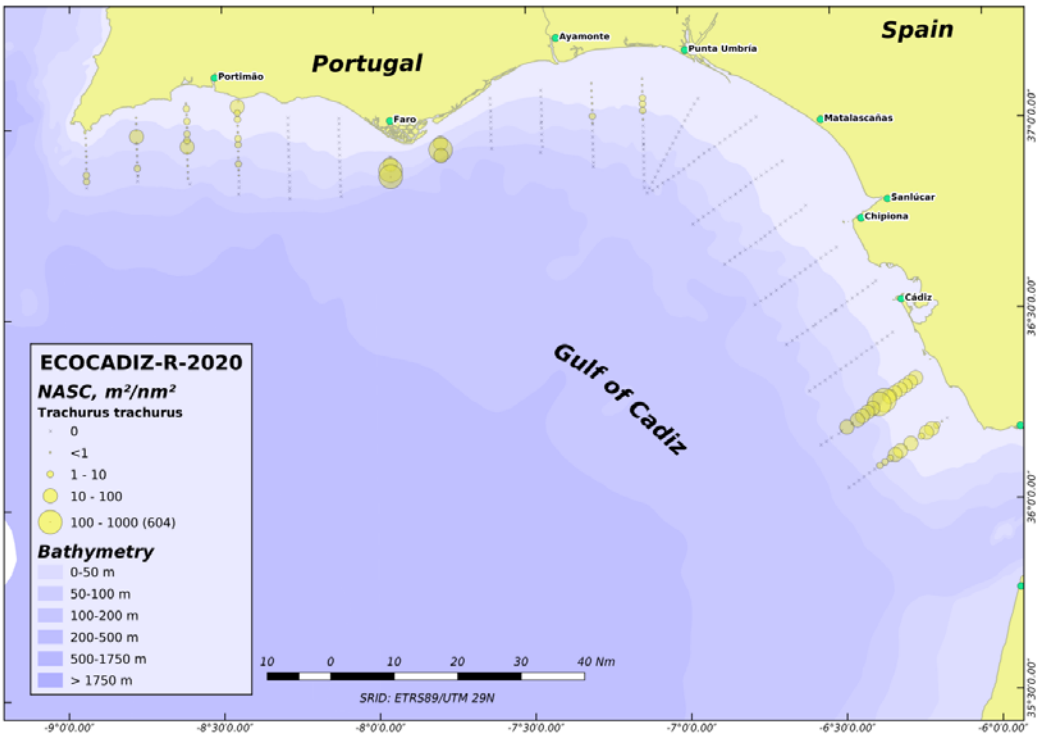

Figure 18. *ECOCADIZ-RECLUTAS 2020-10* survey. Horse mackerel (*Trachurus trachurus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

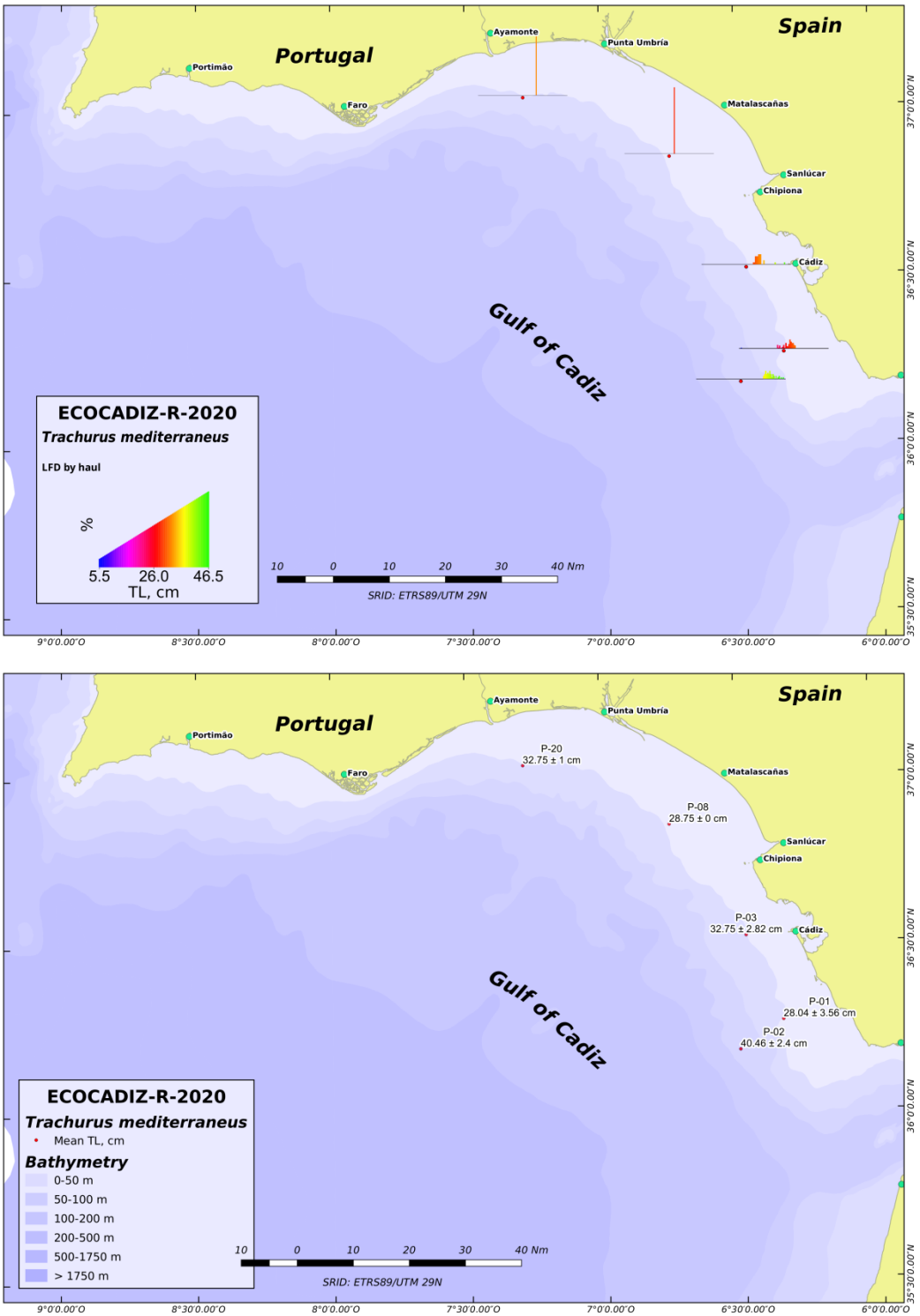

Figure 19. *ECOCADIZ-RECLUTAS 2020-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

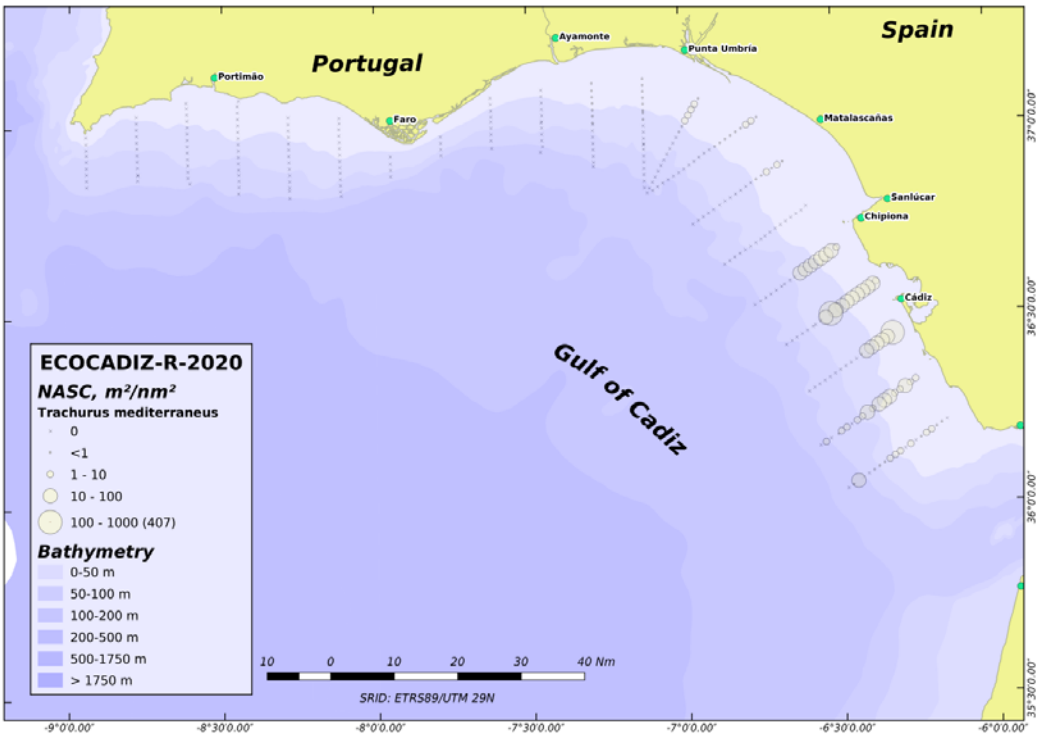

Figure 20. *ECOCADIZ-RECLUTAS 2020-10* survey. Mediterranean horse mackerel (*Trachurus mediterraneus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

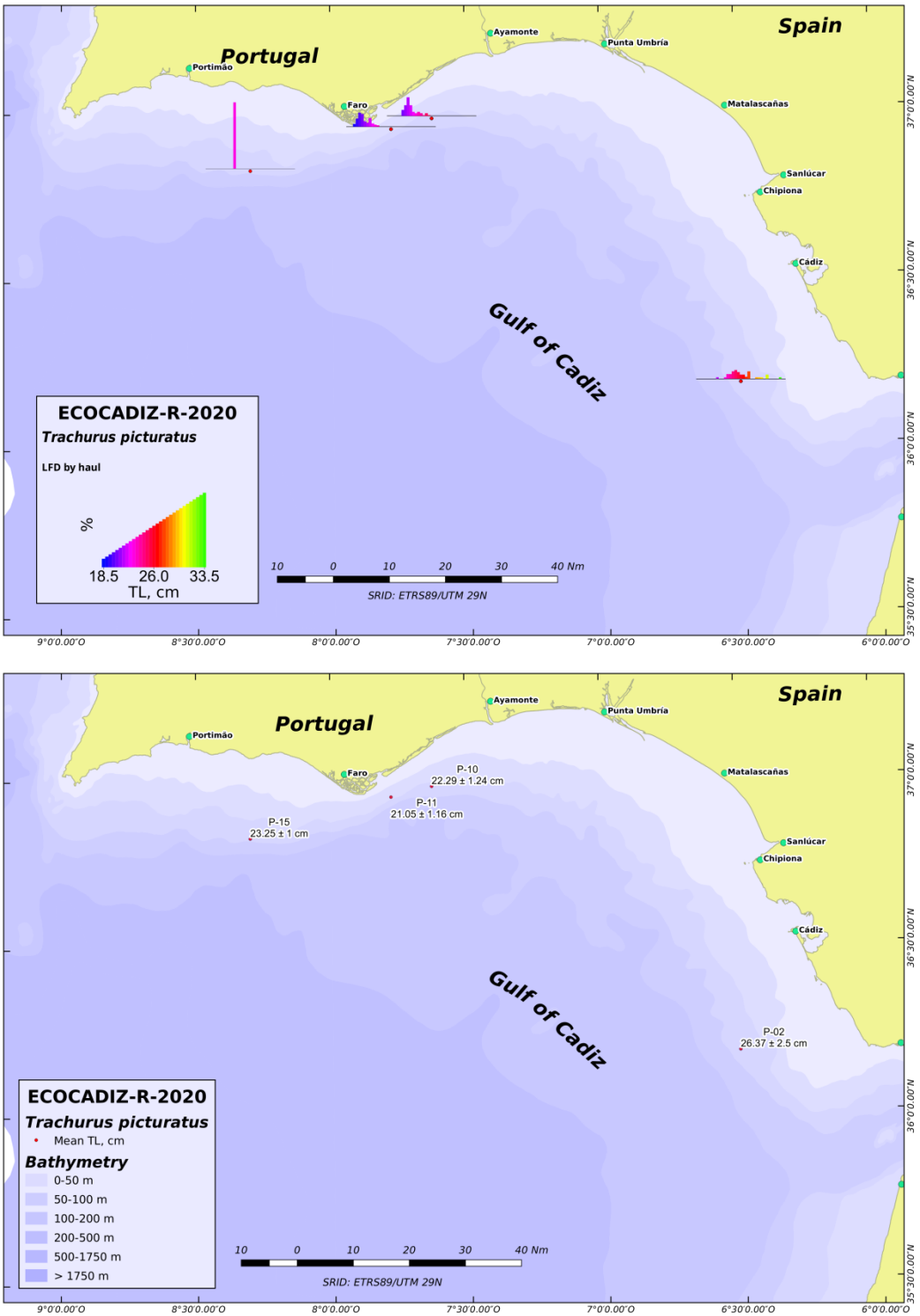

Figure 21. *ECOCADIZ-RECLUTAS 2020-10* survey. Blue jack mackerel (*Trachurus picturatus*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

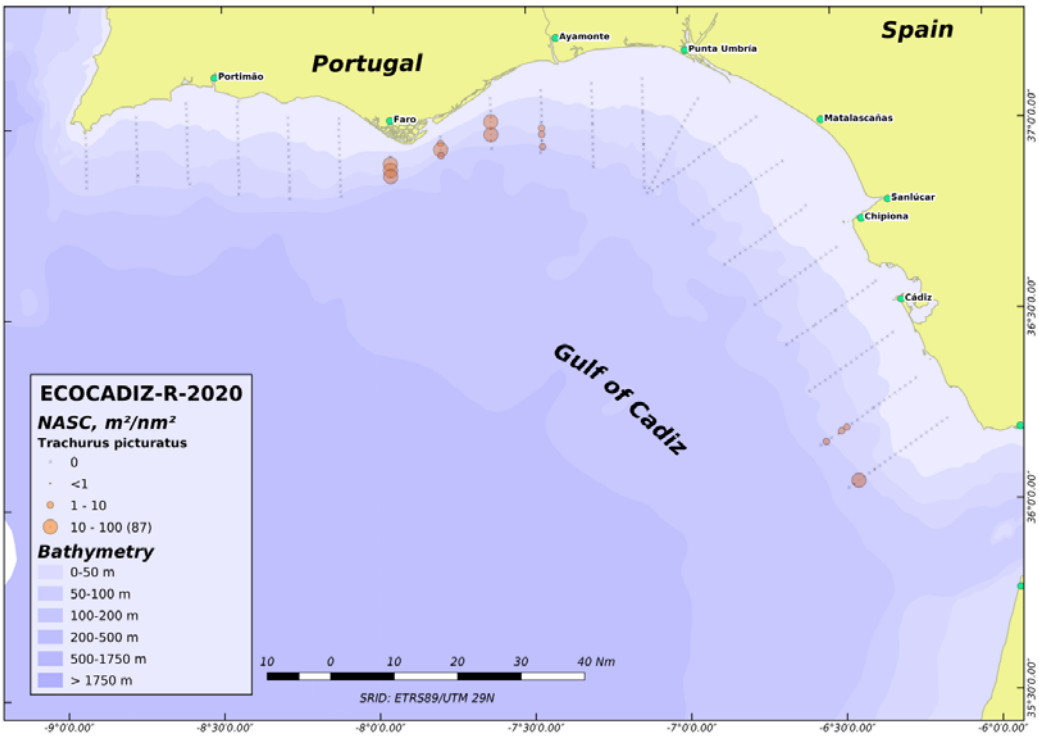

Figure 22. *ECOCADIZ-RECLUTAS 2020-10* survey. Blue jack mackerel (*Trachurus picturatus*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

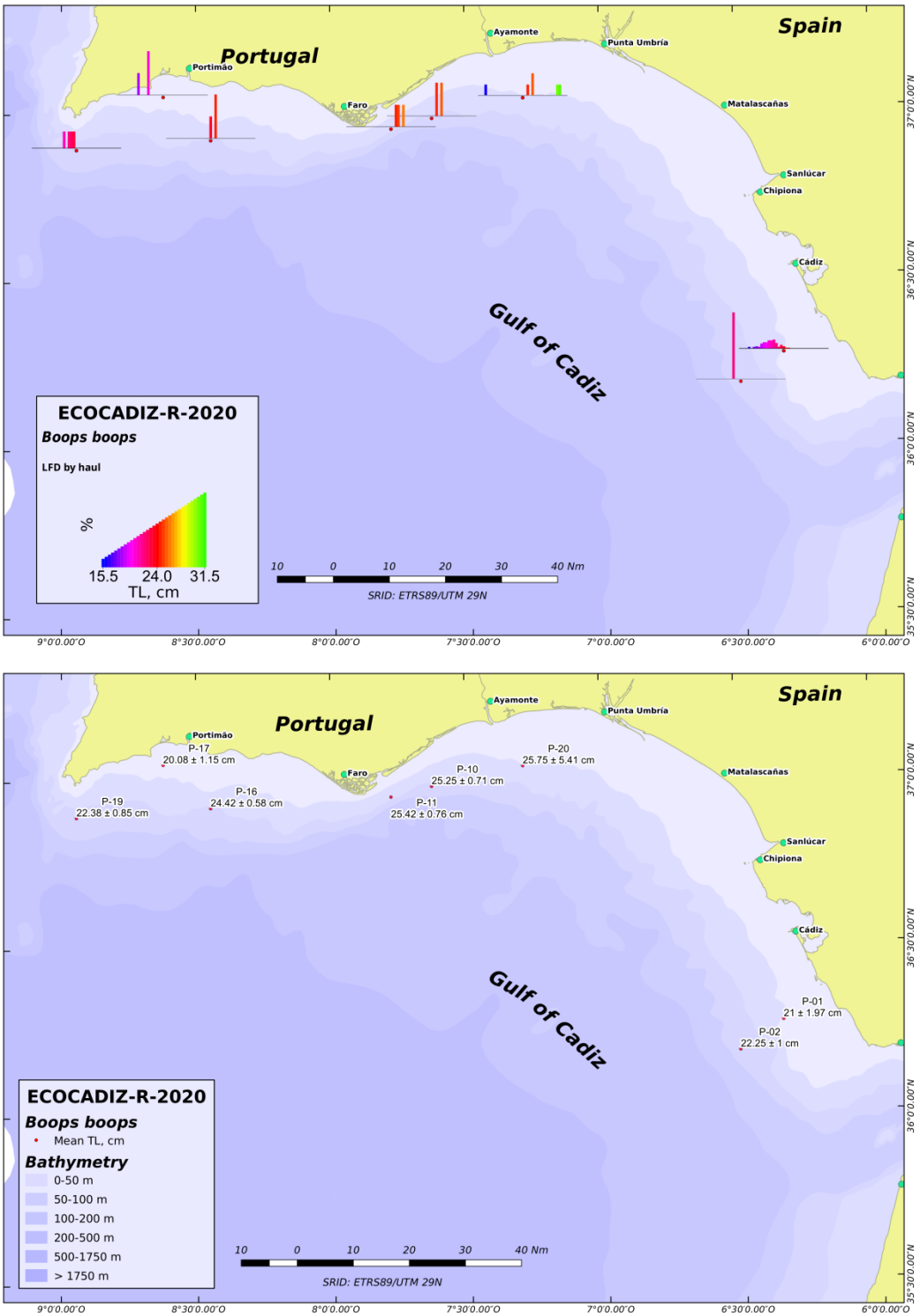

Figure 23. *ECOCADIZ-RECLUTAS 2020-10* survey. Bogue (*Boops boops*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

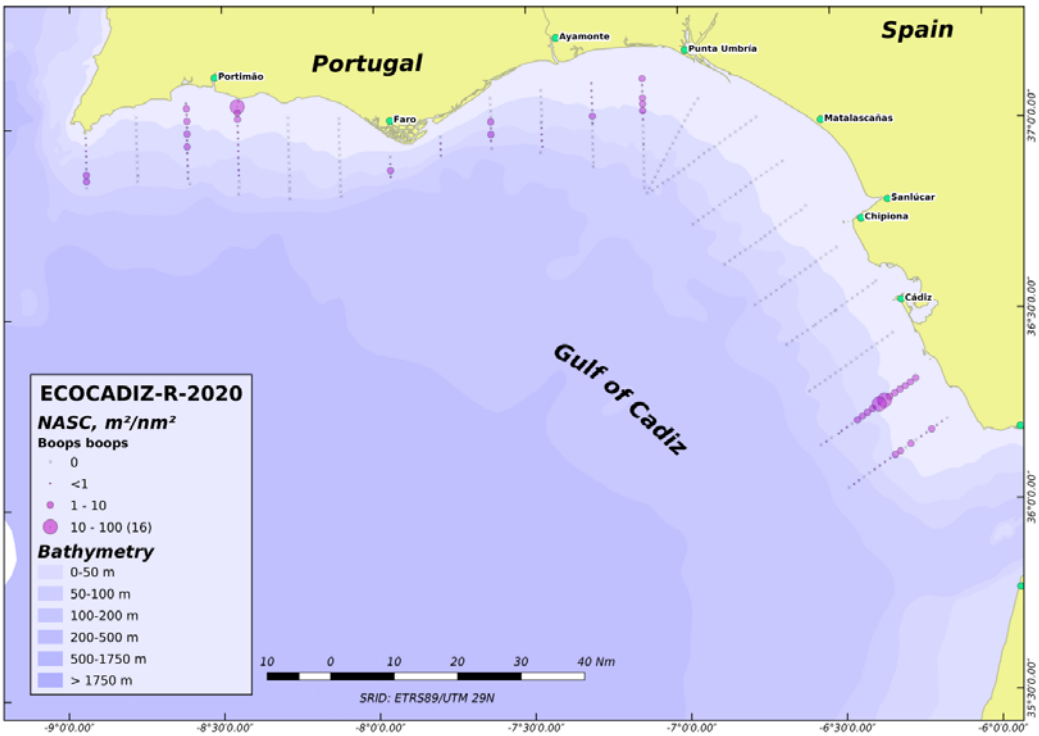

Figure 24. *ECOCADIZ-RECLUTAS 2020-10* survey. Bogue (*Boops boops*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

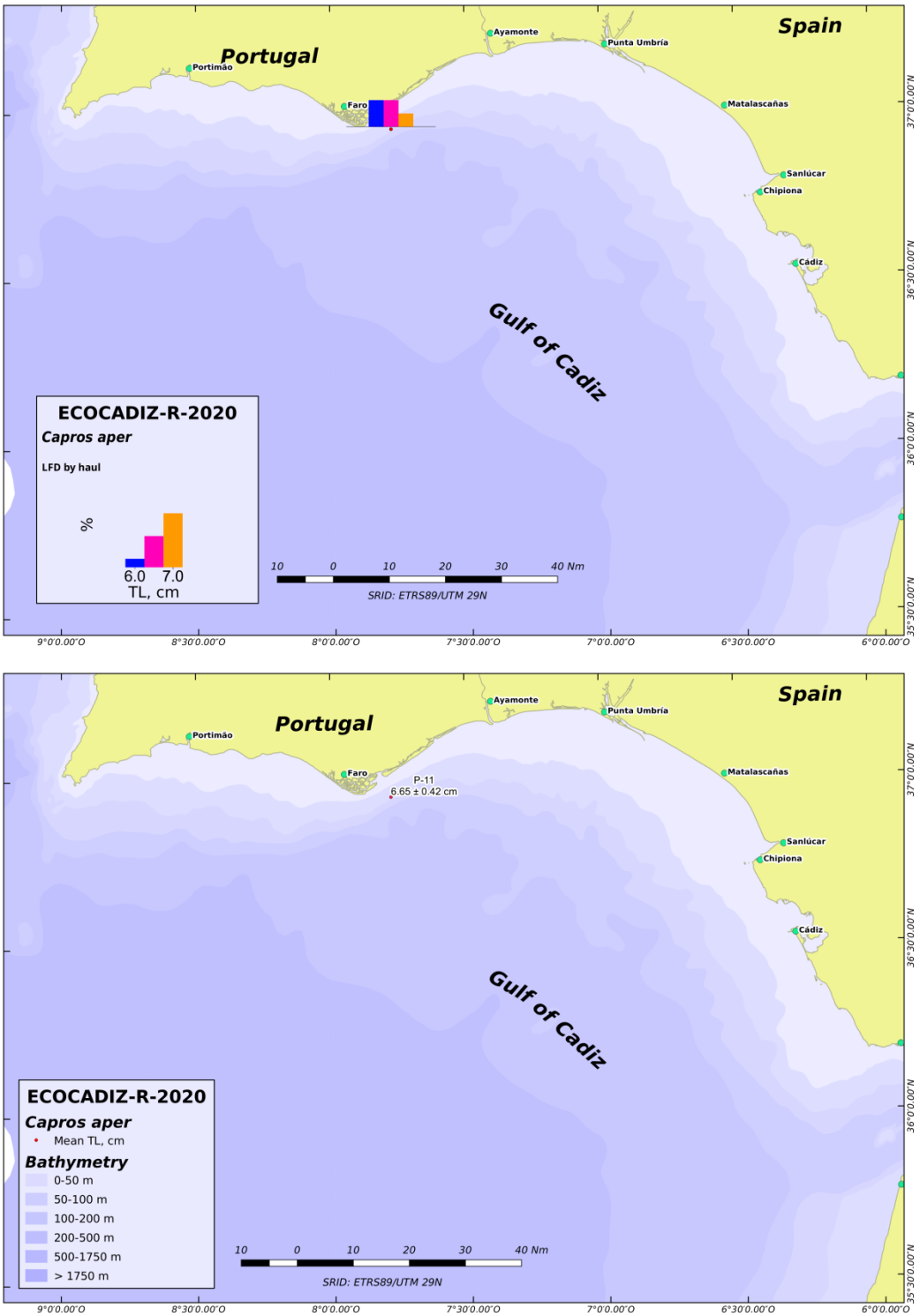

Figure 25. *ECOCADIZ-RECLUTAS 2020-10* survey. Boarfish (*Capros aper*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

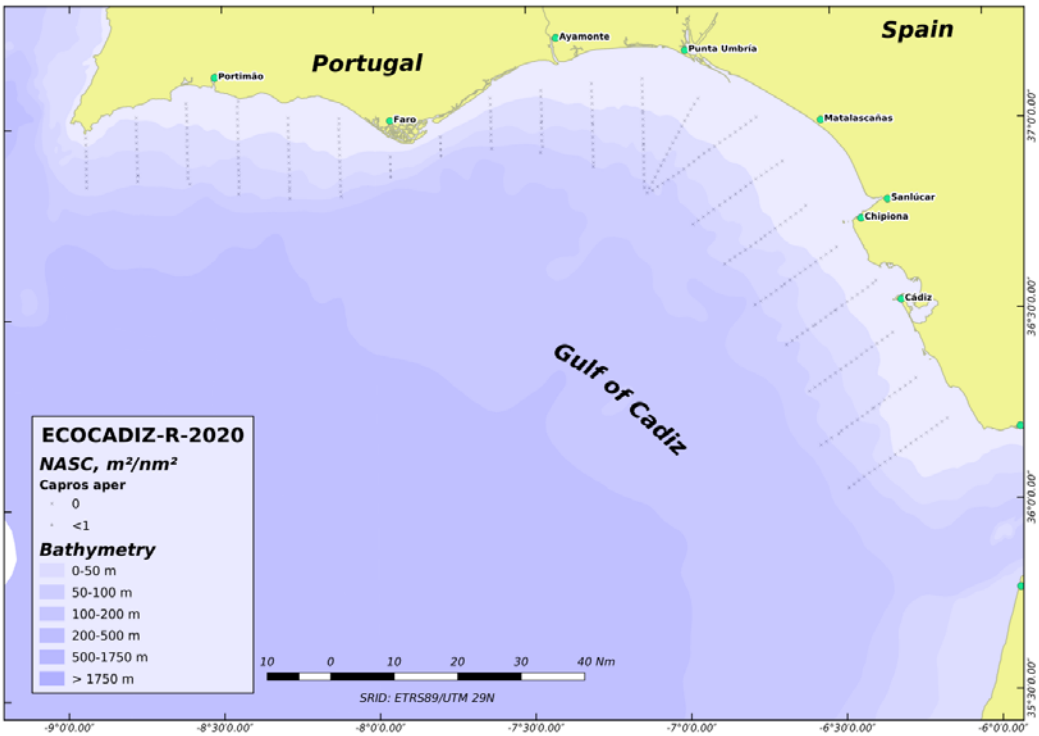

Figure 26. *ECOCADIZ-RECLUTAS 2020-10* survey. Boarfish (*Capros aper*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

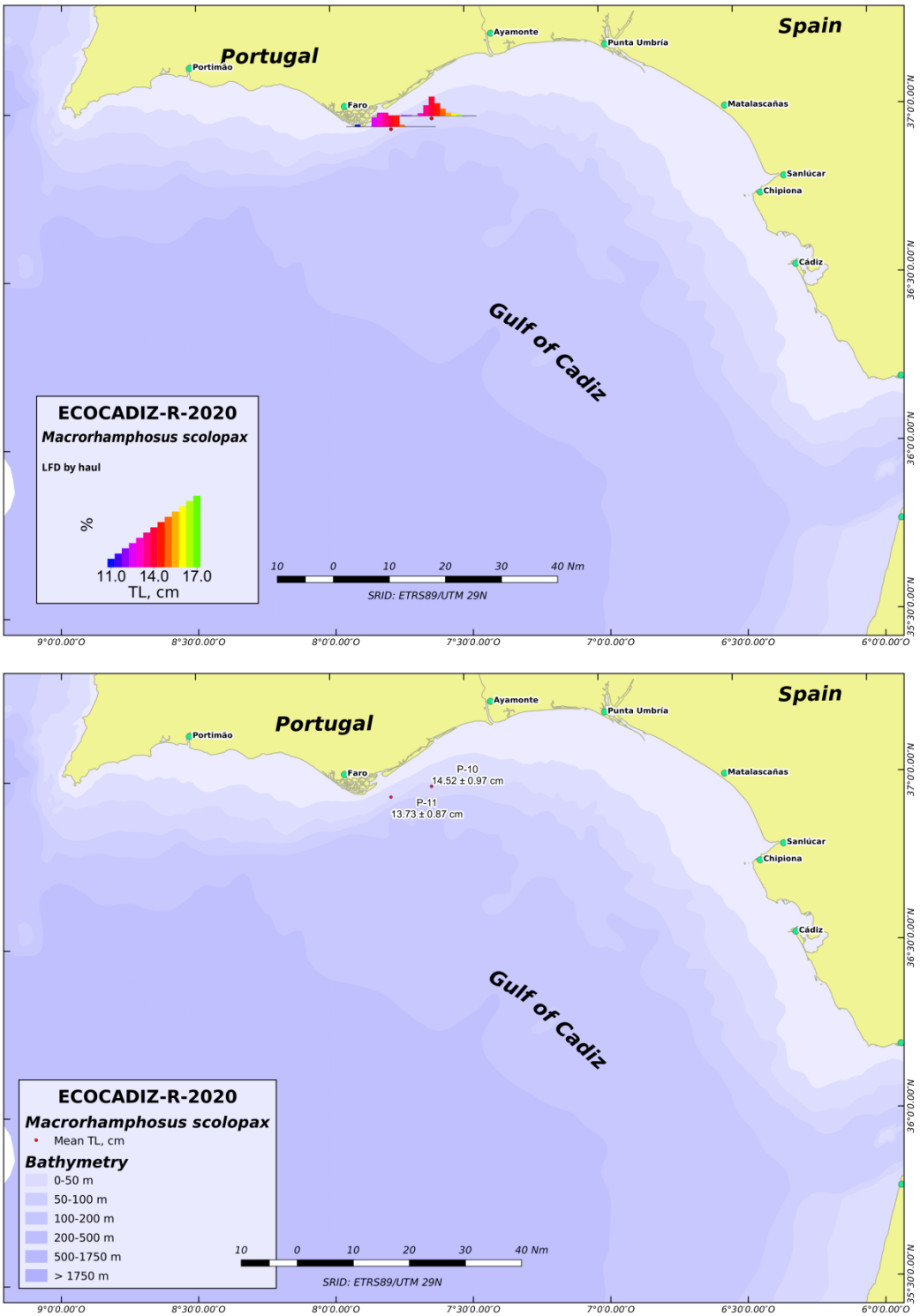

Figure 27. *ECOCADIZ-RECLUTAS 2020-10* survey. Longspine snipefish (*Macroramphosus scolopax*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

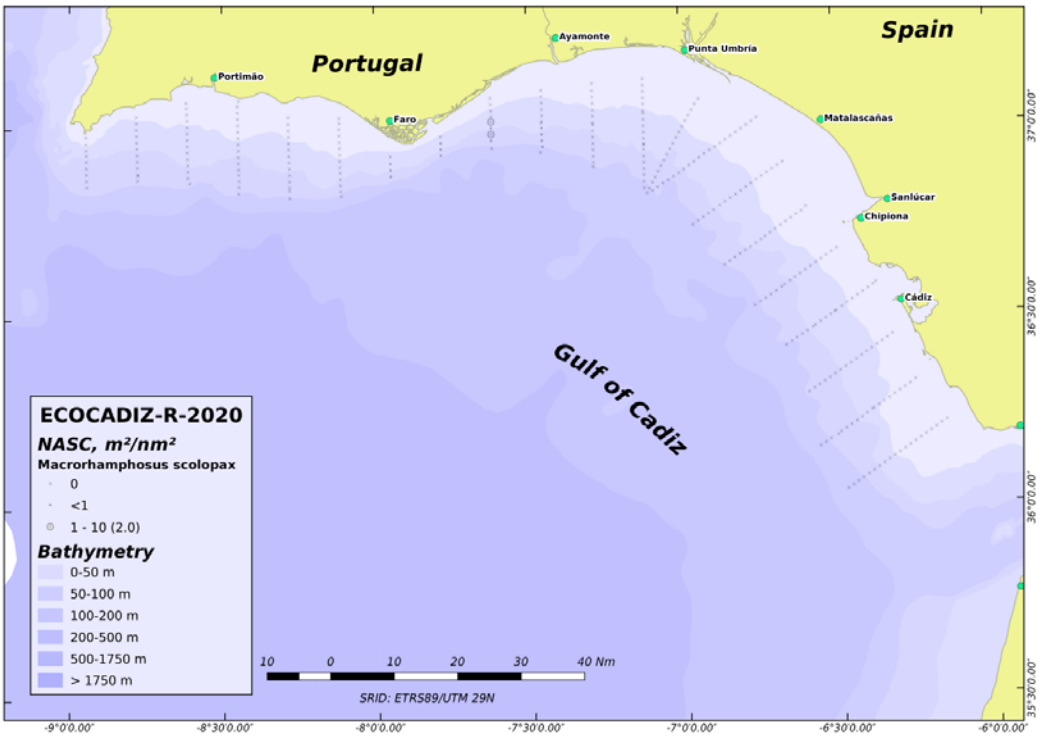

Figure 28. *ECOCADIZ-RECLUTAS 2020-10* survey. Longspine snipefish (*Macroramphosus scolopax*). Top: distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species. Bottom: distribution of homogeneous size-based post-strata used in the biomass/abundance estimates. Colour scale according to the mean value of the backscattering energy attributed to the species in each stratum.

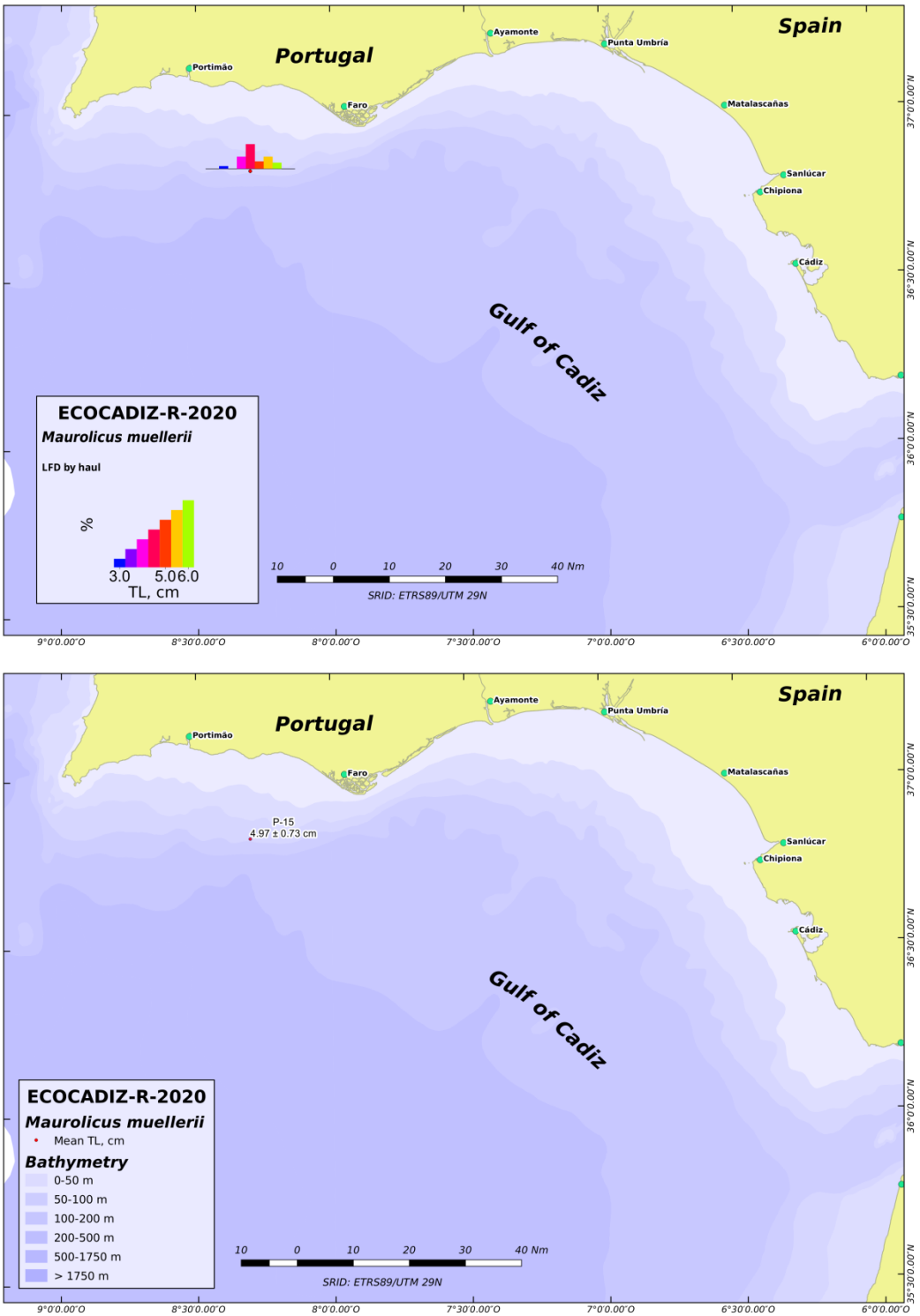

Figure 29. *ECOCADIZ-RECLUTAS 2020-10* survey. Pearlside (*Maurolicus muelleri*). Top: length frequency distributions in fishing hauls. Bottom: mean ± sd length by haul.

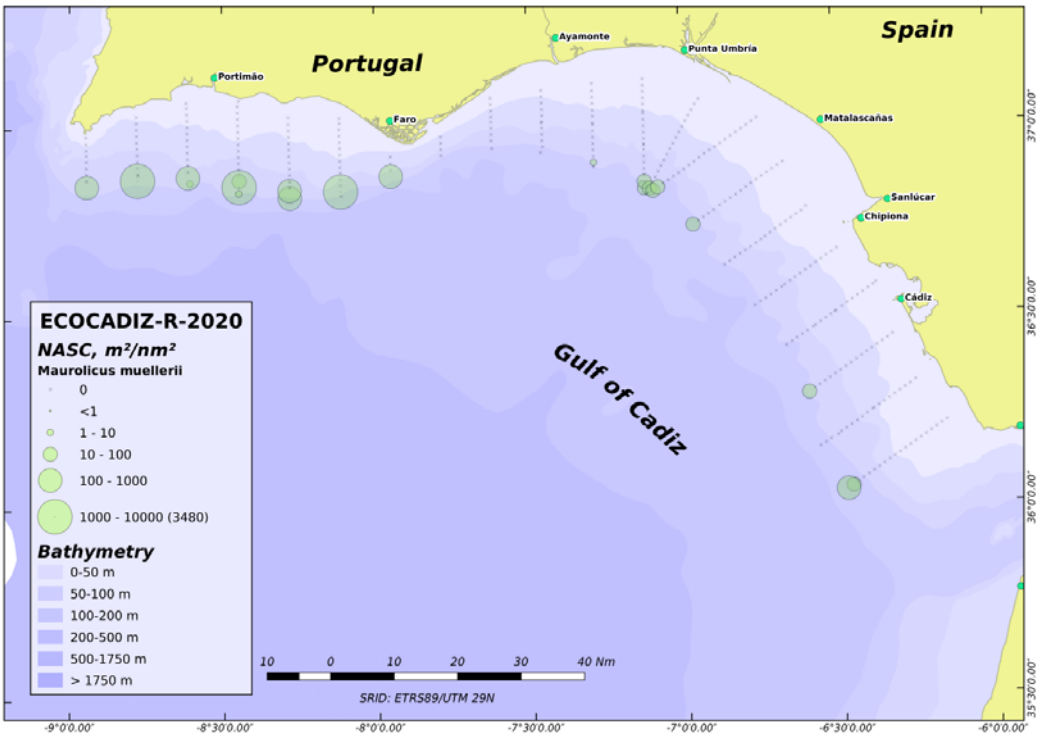

Figure 30. *ECOCADIZ-RECLUTAS 2020-10* survey. Pearlside (*Maurolicus muelleri*). Distribution of the total backscattering energy (Nautical area scattering coefficient, *NASC*, in m^2 nmi^{-2}) attributed to the species.

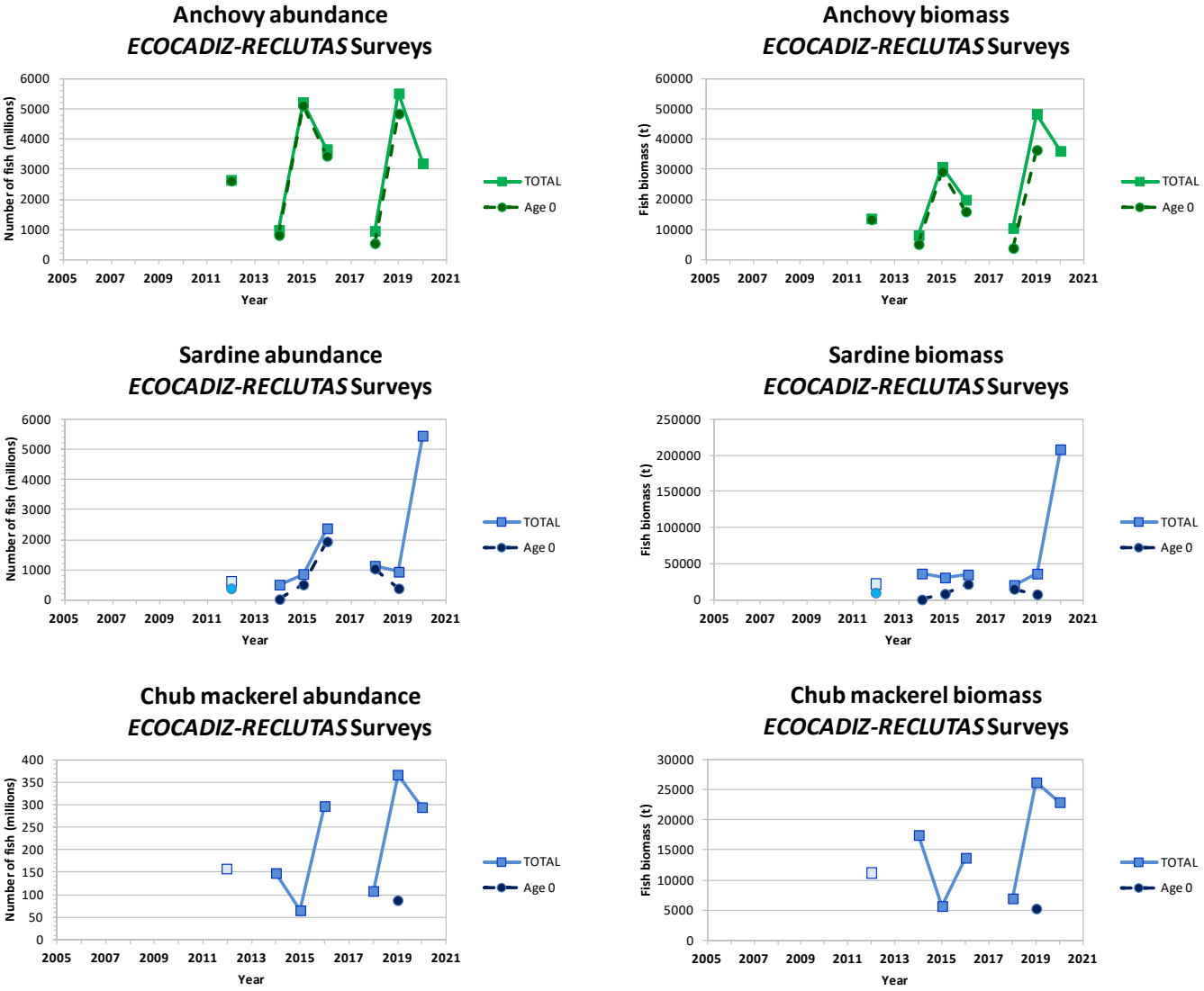

Figure 31. *ECOCADIZ-RECLUTAS* surveys series. Historical series of autumn acoustic estimates of anchovy and sardine abundance (million) and biomass (t) in Sub-division 9.a South. The estimates correspond to the total population and age 0 fish. Age 0 estimates for 2020 are not yet available. The 2012 survey only surveyed the Spanish waters. No survey was conducted in 2013. Although a survey was conducted in 2017, the survey was interrupted for a serious breakdown of the vessel's propulsion system and no estimates were computed. The 2018 estimates should be considered with caution because a possible under-estimation.